DEPARTMENT OF AGRICULTURE.

SPECIAL REPORT.

Dept Rept 27

INVESTIGATION

OF

SORGHUM

AS A

SUGAR-PRODUCING PLANT.

SEASON OF 1882.

PETER COLLIER,
CHEMIST.

WASHINGTON:
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INVESTIGATION OF SORGHUM AS A SUGAR-PRODUCING PLANT.

Hon. GEO. B. LORING,
Commissioner:

SIR: I have the honor to submit the following report of the work performed during the season of 1882 in the investigation of sorghum as a sugar-producing plant.

The work of the past year has been limited mainly to the daily examination of a large number of sorghums wholly new to this country. This work has fully confirmed the results obtained in previous years in this investigation, and has left no longer room for doubt but that we have, in the many varieties of this plant, an abundant source of sugar, which it appears may be, by skill and careful supervision, economically produced.

The work of the past season is briefly set forth in the following report:

VARIETIES PLANTED.

The different varieties of sorghum planted consisted of:

1st. Six varieties from Northern China, received through James B. Angell, late minister to China.

2d. Thirteen varieties from Natal, South Africa, received from the Royal Botanical Gardens, through W. T. Thiselton Dyer, Esq., Assistant Director Royal Gardens, Kew, England.

3d. Two varieties from Cawnpore, India, also received through Mr. Dyer.

4th. Nineteen varieties from various parts of the United States, many of which were new to the Department, the rest having been examined in previous years, and were now again grown for the purpose of confirming results already secured with them, and also for the purpose of comparison with those foreign varieties which were quite new to the country.

The names of the above varieties in order were as follows:

From China:

No. 1. Hwong Mao Nien Liang (Yellow Cap Glutinous Millet)
No. 2. San sui Hoong Liang (Separated Head Stalks Red Millet).
No. 3. San sui Pai Liang (Separated Head Stalks White Millet).
No. 4. Er chin Hung Liang (Second Autumn Red Millet).
No. 5. Ma Wei Nien Liang (Horse Tail Glutinous Millet).
No. 6. Ta Min Hung Liang (Large People's Red Millet).

From Natal, South Africa:

No. 7. Undendebule.
No. 8. Ukubane.
No. 9. Jyangentombi.
No. 10. Jyenga.
No. 11. Ibohla.
No. 12. Dindemuka.
No. 13. Uboyana.
No. 14. Umgatubanda.
No. 15. Ubehlana.
No. 16. Ufatane.
No. 17. Unkunjana.
No. 18. Hlogonde.
No. 19. Unhlokonde.

From the United States:

No. 20. White Imphee. John N. Barger, Lovilia, Iowa.
No. 21. White African. John N. Barger, Lovilia, Iowa.
No. 22. White Mammoth. Amos Carpenter, Carpenter's Store, Mo.
No. 23. West India Sugar Cane. D. C. Snow, Lamoille, Iowa.
No. 24. New Variety. F. W. Stump, Marshall, Ill.
No. 25. Early Amber. Carll and Gardner, from Minnesota.
No. 26. New Variety. Hampden Sidney College, Va.
No. 27. Bear Tail. Jacob Latshaw, Cedarville, Ill.
No. 28. Iowa Red Top. Jacob Latshaw, Cedarville, Ill.

From Cawnpore, India:

No. 29. Black Sorgho.
No. 30. Red Sorgho.

From the United States:

No. 31. Link's Hybrid. Ephraim Link, Greeneville, Tenn.
No. 32. Standard No. 2. Isaac O. Harrell, Greeneville, Tenn.
No. 33. Neeazana. Blymyer & Co., Cincinnati, Ohio.
No. 34. Gray Top. H. C. Sealey, Columbia, Tenn.
No. 35. White Liberian. D. M. Nesbit, Washington, D. C.
No. 36. White Liberian. Rush G. Leaming, Decatur, Nebr.
No. 37. New Variety. Ephraim Link, Greeneville, Tenn.
No. 38. New Variety. Richard Haswell, Armstrong Grove, Iowa
No. 39. Chinese Imphee. W. A. Sanders, Sanders, Cal.
No. 40. New Variety. D. B. Bradford, Elizabeth City, N. C.

TIME OF PLANTING.

Nos. 1 to 28 inclusive, and Nos. 31 to 36 inclusive, were planted May 24, 1882.

Nos. 29 and 30 were planted May 29, 1882.

Nos. 37 to 40 inclusive were planted June 12, 1882, and owing to Nos. 10, 11, 19, and 28 having failed to germinate, and seed of these varieties being exhausted, Nos. 37, 38, 39, and 40 were planted in their places.

Nos. 1, 2, 3, 4, and 6, were replanted June 12, 1882

The entire plot upon which the above varieties were planted was exactly two-ninths of an acre.

The seed was planted in drills 3 feet apart, and the plants were thinned to about 4 or 6 inches apart in the row.

On the 20th of October, all of Nos. 2, 5, 9 (*a*, *b*, *c*), 20, 22, 24, 26, 29 (*a*, *b*), 31, 40 (*a*, *b*), and the greater portion of Nos. 3, 4, 6, 21, 23, 25, 27, 30, were cut down, and the daily examination of the first-named varieties was necessarily suspended.

Analyses of the remainder were continued until December 8, when unfortunately the entire field was cleared, although the average results of the examinations made on the 8th showed that in spite of many frosts (13 in all, the first frost being on November 3) the amount of sugar in the several varieties had suffered no diminution.

SIGNIFICATION OF THE NAMES OF THE IMPHEES.

It will be observed that in the names given to the different varieties of sorghum, there is a tendency on the part of those cultivating them to describe them by their physical peculiarities. Thus we have the Sprangle Top, which has a loose waving head; the Sumac, which in its close compact panicle resembles the seed head of the sumac, so well known to our farmers; the Gooseneck, owing to the bent head of this variety, a characteristic which is not uncommon with several other varieties. So, too, in the Chinese names we have the Separated Head Stalks, red and white; the Horse Tail, &c. Also in the South African varieties the same tendency appears in the names, as, for example, Jyenga means loose-headed, waving; Hlogonde is long-head, &c.

In this connection the following letters will be found of interest, received from J. Shepstone, Assistant Secretary for Native Affairs, Natal, and Miss Colenso, the daughter of Bishop Colenso, to whom, through the kindness of W. T. Thiselton Dyer, Esq., Assistant Director Royal Gardens, Kew, England, were submitted lists of those names of unmistakably South African origin which are found in the literature of sorghum in this country during the past thirty years. Also a letter from the pioneer of this sorghum industry, Leonard Wray, Esq., now resident in Southern India.

Secretary of Native Affairs to Colonial Secretary, Natal.

I cannot give the meaning of the generic term Imfe, nor can I find natives that can do so. The natives that I have spoken to only know of six varieties of the Imfe, of which I will give the names and derivation.

1. Iyeng-a (enticer), from its drooping or waving ear or head of corn.
2. Umbemba (sprouts or shoots), this cane invariably having small shoots from each joint.
3. Uzimumana (the enwrapped), from the close adherence of the outer leaves to the cane.
4. Umapofu (the yellow), from its yellow color.

5. Ihlosa (the prominent), from its growing generally higher than other corn with which it is sown.

6. Unfenkulu (the great Imfe), from its large size.

The names given in the list inclosed by you are, I believe, repetitions obtained from different tribes, many having names according to the dialect spoken: the names are also badly spelled.

J. SHEPSTONE,
Assistant Secretary for Native Affairs.

LIST OF IMPHEES RETURNED BY MISS COLENSO.

Undendebule. Not recognized, but the word Ukudendebuleka means capable of being peeled straight down through the joints.

Umkunyana. Not recognized, but the word should mean rather hard.

Unhlokande, Hlogonde, Slagonda. The first means long head; the others are the same word misspelled.

Ibohla. Probably means causing flatulence.

Iyenga, Engha, Eenga. The first means loose-headed, waving; the others are the same word misspelled.

Umnyani-mude, with long flower-stalk or head. The head in this variety is still longer than that of the Unhlokonde.

Boomvana, Boomvwana, Booena. The first means small red or rather red: the last two names are misspelled.

Uzimumana, Limmoomana, Zimmoomana. The first means close, thick-headed; the last two names are misspelled.

Hlakuva, called so after the castor-oil plant, the seeds being thought to look alike; a very small-headed, short variety.

Zimbazana, called so after Izimba, a variety of Kafir corn, because very like it. Izimba is used as grain in making beer; Zimbazana may be used so also.

Ihlosa, budding, beginning to swell, a variety which looks young when already grown.

Ehwafla, Ehahla. Not recognized, but evidently the same.

Koomhana, Koombanna. Not recognized, but evidently the same.

Ubayana, Ukubane, Ubehlana, Iyangenbambi, Dindemuka, Ugabane, Umgatubanda, Oomseeana, Neeazana, Sangokahea, Vimbischuapa. None of these names are recognized.

LIST OF RIPE PANICLES OF IMPHEE.

[Contained in a parcel received from William Keit, Esq., Director of the Royal Botanical Gardens, Natal.

Iyenga	Imphee.
Ufatana	Imphee.
Ubehlana	Imphee.
Undendebule	Imphee.
Dundamuka	Imphee.
Umkunyana	Imphee.
Hlogonde	Imphee.
Umgatubanda	Amabele.

RIPE PANICLES.

[Received from Dr. Dalzell, Gordon Memorial Mission, Natal.]

U-Dwe	Imphee.
M-behlana	Imphee.
Iyenga	Imphee.
U-fengkule	Imphee.
Ihlosa	Imphee.
Dindemuka	Imphee.
Hlogonde	Imphee.
Ukabane	Amabele.
Umquatubanda	Amabele.

[From a letter received from Leonard Wray, dated Perak *via* Penang, September 7, 1882.]

I am pleased beyond measure to find that the United States Government has *at last* awakened to the great value af the imphee varieties which I introduced into your country, and has taken the most certain course to verify, by scientific tests, the truth of my printed statements respecting them, published in English and also in French in 1854; and if you will do me the honor to read that, you will, I am sure, fairly acknowledge that every statement I therein made is *strictly proven* by the valuable results of the able men whom you selected to conduct your experiments. I first became acquanted with these plants in March, 1851, just after my arrival in Natal, South Africa; and in 1854 I grew them in several parts of France, in England, Spain, Italy, and in various other places, so that I may claim to know their merits, and I *now* say that all I said and wrote about them at *that* time, I am still fully prepared to stand by and substantiate the truth of. In fact, your admirable Department has, in its recent scientific demonstrations, abundantly and authoritatively confirmed my facts, and thereby rendered an inestimable service to your country and to other countries also. I hope and trust you will continue it.

Looking at the beautiful plates in your reports, I cannot but express my admiration, and at the same time my astonishment, at any remarkable *constancy* of the types maintained by the different sorts of imphee shown. For instance, I may mention Plate 1, facing page 3, in special report 33. This is there called Imphee, Liberian, and Sumac, but I distinctly recognize it as my Koom-ba-na, one of the very sweetest and best I had. (I inclose you some very old seed.)

Plates 2, 3, and 4, are my Nee-ā-zā-ñā and its sports.

Plate 5 is my En-ya-mā, which I see figures as White Mammoth. I inclose a few of my old seeds of it.

Plate 7 is my Oom-see-a-na.

Plate 8 seems to me to be the regular Chinese Sorgho.

Plate 9 is an Oomseeana kind (no doubt a sport).

Plate 10 is undoubtedly my Vim-bis-chu-a-pa, which, to please General Hammond, I nicknamed Sorgho-ka-Bai (or Sorgho's brother). Some grew to 6 pounds' weight, when topped, and I had the head of one such until about nine months ago, when I unluckily threw it away (it was 20 inches long). I see you call it by the names of Honduras, Honey, Mastodon, &c.

Plate 11 seems to me to be no other than my Boom-vwa-na, one of my special favorites. Please see description in my little pamphlet (in Olcott's Book, 1857), and I think you will not long be in any doubt about its origin, bogus stories notwithstanding.

Plates 12 and 13 are both my imphees, and I had some growing here twelve months ago, but the seed unfortunately got spoiled. The seed you were kind enough to favor me with I have sown, and had sown by my friendshere, and mine are now eight inches high, being only sixteen days' growth. I may mention that I soaked my seed on this occasion in a strong solution of sugar, with a little salt, camphor, and soapsuds for twenty hours, and I think they are growing much more vigorously than those not so treated.

The above extracts from the letter of Mr. Wray throw much light upon several matters of very great practical importance, and fully confirm the results of our own observations. He is astonished at the very remarkable constancy maintained by the several varieties.

The impression, which has prevailed almost universally, to judge from the statements made in the papers upon sorghum, has been that only by the greatest care can crossing or hybridizing of the several varieties be prevented.

During the past five years there have been grown, in all, at least one hundred varieties, and these have been separated in rows only three feet apart. Although it is possible that certain crosses have taken place and been unobserved, it is certain that no evidence has been seen of such fact. Each variety has maintained its individuality, and the seed secured has a second year produced its kind.

It is in this connection remarkable that Mr. Wray should be able, even from plates, which fail to represent many of the marked peculiarities of the different varieties, to at once recognize almost every one as among those introduced by him over thirty years ago; and it is to be remarked that in the case of the two specimens of seed sent by him, of his old varieties, they are beyond question identical with those represented in the plates. It would appear incredible, if this tendency to cross or sport was in any degree marked, that these varieties could have been grown by our farmers for thirty years, and have maintained their individuality. In regard to the White Mammoth, Mr. Wray's En-yā-mā, the only specimen received by the Department came from Western Missouri. The Liberian, Chinese, Sumac, Imphee, Mr. Wray's Koom-ba-na, has been sent to the Department from every section of the country, under very many names, but always so clearly defined by its peculiarities as to be recognized without a moment's hesitation. It is therefore most probable that his positive identification of other varieties cannot be mistaken; and it will be observed that among these is our Early Amber, Mr. Wray's Boom-vwa-na. It is even more remarkable that of the thirteen varieties of seed sent from the Botanical Gardens of Natal, or of the ripened panicles received from Dr. Dalzell, of the Gordon Memorial Mission, nine in number, and those from Mr. Keit, of the Botanical Gardens at Natal, eight in number, not a single one could be recognized as belonging to any of those varieties imported orginally by Mr. Wray, and for thirty years past grown in this country. The same appears equally true of all the varieties grown from the seed received from Cawnpore, India, and Peking, China; every one appears an entirely new variety.

Since very many of the Indian and African canes are remarkably rich in sugar, as will be seen by the results of the examination, it would appear that the possibilities of securing other varieties from the one country or the other even better adapted to our soil and climate than any hitherto found, are far from being exhausted. It appears hardly pos-

sible that the natives of Africa and India growing this plant have themselves recognized the several varieties since even those seeds received by the Department, and planted, were found to be greatly intermixed, not only with each other, but with many other varieties which did not agree in character with any of those sent. This will account for the subdivision of the tables of analyses into, *e. g.*, No. *a*, *b*, *c*, *d*, *e*, &c., which will be explained further on. It would appear desirable that some intelligent observer should visit these countries at the proper time, and by personal examination of the growing plants secure specimens of the seed of the several varieties, especially of such as should appear new to this country.

It is hardly possible that in a country where millions of the inhabitants are mainly, and for centuries have been, dependent upon it for food, as in Northern India, only two varieties of this plant are grown. It is to be expected that there, if anywhere, valuable varieties might be secured, especially since the two received proved to be exceptionally good.

NEW VARIETIES IDENTIFIED.

It has been mentioned that although there were nominally but six varieties of seed from China, thirteen from South Africa, and two from Northern India, it was found that some of the varieties of seed sent, upon growing, contained several distinct kinds.

Generally the one which was most abundant in each row was regarded as the one to which the attached name belonged, but it happened sometimes that the name was sufficiently descriptive to enable us, together with the full panicles received from Natal, to identify the various kinds beyond question.

The following varieties have been thus identified, and will hereafter receive the names attached to them.

EAST INDIAN VARIETIES.

Black Sorgho is No. 29*a*.
Red Sorgho is No. 30.

SOUTH AFRICAN VARIETIES.

Undendebule is No. 7.
Ukubane is No. 8*b*.
Iyangentombi is No. 9*a*.
Iyenga is No. 10.
Ibohla is No. 11.
Dindemuka is No. 12.
Uboyana is No. 13.
Umgatabanda is No. 14.
Ubehlana is No. 15*b*.
Ufatane is No. 16*b*.
Unkunjana is No. 17.

Hlogende is No. 18*a*.
Unhlokonde is No. 19.

CHINESE VARIETIES.

Yellow Cap Glutinous Millet is No. 1*a*.
Separated Head Stalks Red Millet is No. 2*a*.
Separated Head Stalks White Millet is No. 3*a*.
Second Autumn Red Millet is No. 4*a*.
Horse Tail Glutinous Millet is No. 5*a*.
Large People's Red Millet is No. 6*a*.

The above lists of recognized varieties include but twenty-one of these which were seen to be distinct. There were, however, in all fifty varieties differing so widely from each other that it was thought advisable to photograph the panicles and preserve the same for future reference.

It is not unlikely that in the samples of seed sent there was not sufficient care taken to keep them distinct, and this appears probable from the close resemblance of certain of the scattered plants in one row to the leading variety of another row. For example, No. 16*c*, the odd canes in No. 17 and No. 18*b*, all closely resemble No. 13; so, too, No. 15*a* resemble No. 7, also No. 3*a* is probably the same as No. 4*b*, and the odd canes in No. 2. There is also a close resemblance between the Indian varieties No. 29*a* and Nos. 12, 17*a*, and odd canes in No. 13, and yet these last are from seed which unquestionably came from Natal. It is of course possible, if not even probable, that a thorough examination of the different varieties of the sorghums, especially of South Africa, and Southern Asia, will establish the identity of many varieties now grown in both sections, if not their common origin.

STAGES OF DEVELOPMENT.

For the purpose of indicating the condition of the plants when taken for examination a record was kept as in previous years of certain physical characteristics by which the degree of development could be determined, and the several stages selected were as follows:

First stage.—Panicle swelling, but not out.
Second stage.—Panicle fully out.
Third stage.—Before bloom.
Fourth stage.—In full bloom.
Fifth stage.—After bloom.
Sixth stage.—Seed in milk.
Seventh stage.—Seed in dough.
Eighth stage.—Seed hard.
Ninth stage.—Sucker seed in milk.
Tenth stage.—Sucker seed in dough.
Eleventh stage—Sucker seed hard.

TIME FROM PLANTING REQUIRED TO REACH CERTAIN STAGES OF DEVELOPMENT.

The following table gives the number of days after planting required by the several varieties to reach certain stages of development. This table can be regarded as only relatively true for these varieties during the season of 1882, which season has been remarkable for an unusual rainfall during the summer months, thus retarding the development of the plants probably beyond the period they would require under ordinary conditions of climate.

A reference to the meteorological data of this year as compared with 1881 will make the difference in the two years manifest:

Time from planting to reach certain stages of development.

Row number.	Variety.	Maximum height attained.	Days from planting to maximum height.	Days from planting to blossom.	Days from planting to seed in milk.	Days from planting to seed in dough.	Days from planting to seed hard.
1*a*	Yellow Cap Glutinous	9.3	74	67			
1*b*	do						
2	Separated Head Stalks Red	9.3	74	53	60	74	81
3*a*	Separated Head Stalks White	9.6	74	67	77	88	97
3*b*	do	9.6					97
4	Second Autumn Red	9.4	67	60	74	81	90
5	Horse Tail Glutinous	10.0	86	72	79	90	104
6	Large People's Red	9.6	74	74	88	95	117
7	Undendebule	9.6	93	90	107	115	124
8*a*	Ukubane	9.6	93	79	86	93	100
8*b*	do	5.6	93	86	100	107	116
9*a*	Jyangentombi	8.6	86	93	107	110	116
9*b*	do	7.0	93	86	100	114	136
9*c*	do	9.0					
10	Iyenga						
11	Ibohla	11.4	100	97	107	111	115
12	Dindemuka	8.0	100	86	93	124	136
13	Uboyana	8.2	109	100		124	143
14	Umgatubanda	7.0	100	86	100	107	115
15*a*	Ubehlana	9.0	93	93	107	115	124
15*b*	do	8.3			143		
16*a*	Ufatane	8.10	100	93	107	115	124
16*b*	do	6.1	100	93	108	124	143
16*c*	do	7.8	100	93	108	124	143
17*a*	Unkunjana	9.2	100	93	107	124	143
17*b*	do	10.6	100		115	124	136
17*c*	do	7.5	100		115	124	143
18*a*	Hlogonde	8.9	109	93	107	124	129
18*b*	do	7.4	109		108	124	129
19	Unhlokonde	9.2	79	72	93	107	115
20	White Imphee	8.1	79	79	93	100	107
21	White African	9.6	93	86	100	107	115
22	White Mammoth	10.3	93	86	100	107	115
23	West India	8.6	100	100	105	110	115
24	New Variety Stump	9.2	86	65	86	93	100
25	Early Amber	9.0	86		93	100	107
26	New Variety H. S. Coll	9.6	86	65	79	90	100
27	Bear Tail	9.4	102	79	100	107	115
28	Iowa Red Top	8.4	86	79	93	100	107
29*a*	Black Sorgho	7.6	81	74	88	99	110
29*b*	do	8.0	81			99	110
30	Red Sorgho	9.2	95	88	102	110	131
31	Link's Hybrid	9.3	93	93	107	115	130
32	Standard Harrall	9.8	110	93	107	124	129
33	Neeazana	7.3	86	75	86	93	100
34	Gray Top	8.0	93	79	93	100	107
35	White Liberian	9.0	93	65	79	90	98
36	do	8.8	86	72	86	93	100
37	New Variety Link	9.7	81	81	88	95	104
38	New Variety Haswell	9.6	74	67	81	88	95
39	Chinese Imphee	10.3	74	67	81	88	97
40*a*	New Variety Bradford	8.6	74	74	88	104	124
40*b*	do	7.	74			104	124

CHARACTER OF THE VARIETIES OF SORGHUM AS TO HABITS OF SUCKERING.

Owing to the importance of having a uniform crop of cane without any admixture of immature stalks, for the purpose of sugar production, observations were made in the field upon the several varieties of sorghum under cultivation this year for the purpose of determining their character in respect to throwing up suckers from the roots and offshoots from the parent stalk.

The following different classes appeared pretty well defined, but it often happened that one variety would have the characteristics of two or more classes:

First class.—A single stalk from the seed, without suckers from below or offshoots from the stalk.

Second class.—Two or more stalks from the seed maturing with equal rapidity, and without suckers or offshoots.

Third class.—A single stalk from the seed, with no suckers from the roots, but with offshoots from the upper joints of the parent stalk.

Fourth class.—A single stalk from the seed, without offshoots, but with suckers springing up from the roots, and maturing much later than the original stalk.

Fifth class.—A single stalk from the seed, with no suckers from the roots, but with offshoots from every joint of the parent stalk.

It will, I think, be obvious that, other things being equal, the several varieties of sorghum will, for the purpose of sugar production, be valuable according as they belong to the above classes in their order, viz, those of the first or second class most valuable; those belonging to the third next, and so in order.

It was generally found, however, that each variety belonged to two or more of the above classes, and below is given the results of our observations upon the several varieties October 14:

Class 1.—Nos. 8*b*, 10, 11, 16*c*, 17*c*.

Class 3.—Nos. 3*b*, 7, 8*a*, 12, 14, 16*a*, 16*b*, 18*a*, 21, 22, 25, 28, 29*a*, 29*b*, 33, 35, 37, 39, 40*b*.

Class 5.—Nos. 2, 3*a*, 4, 5, 6, 34.

Classes 1 *and* 2.—Nos. 9*b*, 15*a*.

Classes 2 *and* 3.—Nos. 9*a*, 9*c*, 13, 17*a*, 17*b*, 19, 23, 30.

Classes 2 *and* 4.—No. 1.

Classes 3 *and* 4.—Nos. 20, 24, 26, 27, 32, 36, 38, 40*a*.

Classes 3 *and* 5.—No. 31.

Classes 1, 3, *and* 4.—No. 18*b*.

It will of course be understood that the above classification is only relative, and upon other soils and in different conditions than those which prevailed with the plot upon which the above varieties were grown these sorghums would pass from one to another of the classes.

This classification, however, will show the relative tendency of these varieties under conditions which were for each the same; and for any

soil or any climate the choice would be fully justified of only such varieties as stood near the head in the above classification. Of course the relative weight of crop of each variety, its time for maturing, and its relative content of sugar are also to be taken into consideration in selecting the variety best adapted to any given locality.

TEMPERATURE AND RAINFALL FOR 1882.

The following statement, showing the maximum, minimum, and mean temperature, and total rainfall for each day from May 1 to December 15, as also the date and amount of precipitation of each storm, and the date of each frost, has been furnished this Department from the records on file at the office of the Chief Signal Officer:

Statement showing the maximum, minimum, and mean temperatures and the precipitation, in inches and hundredths, at Washington, D. C., for each day from May 1 to December 15, 1882.

Compiled from the records on file at the office of the Chief Signal Officer, U. S. Army, Washington, D. C.]

	1882.															
Day of month.	May.				June.				July.				August.			
	Temperature.			Rain.	Temperature.			Rain.	Temperature.			Rain.	Temperature.			Rain.
	Max.	Min.	Mean		Max.	Min.	Mean		Max.	Min.	Mean		Max.	Min.	Mean	
	°	°	°	In.	°	°	°	In.	°	°	°	In.	°	°	°	In.
1	70.8	42.5	56.8	.....	75.0	58.0	65.4	1.21	88.0	70.6	77.5	.13	73.5	66.1	68.4	.39
2	64.2	45.8	53.3	.....	73.6	51.1	64.4	.....	77.5	66.3	70.2	.01	76.0	65.2	71.1	1.12
3	65.4	37.0	53.1	.....	81.6	57.9	71.6	.....	82.9	59.4	73.0	*—	79.8	68.1	73.2	.01
4	78.8	49.8	65.6	.02	74.0	63.1	68.0	.03	72.5	59.7	64.6	2.00	81.1	70.2	75.6	.03
5	65.1	51.7	56.6	.16	67.1	56.9	61.8	*—	71.3	57.7	64.9	.01	84.5	70.3	77.6	.....
6	52.6	43.0	46.7	.44	74.0	51.8	64.0	*—	79.1	58.9	68.4	.....	86.0	71.9	78.2	.....
7	53.2	42.5	48.4	.28	85.5	55.5	72.3	.....	84.6	58.2	73.3	.....	89.6	73.8	80.1	*—
8	59.3	49.4	55.1	*—	86.5	63.2	74.1	.....	87.4	67.4	76.6	.....	88.5	71.6	78.5	.05
9	86.1	54.8	72.5	.....	86.0	62.9	75.0	.12	91.5	69.3	80.7	.....	86.2	67.1	76.4	*—
10	72.1	60.1	63.9	.26	89.5	68.1	76.7	.20	95.0	71.4	84.0	.....	84.0	63.7	72.6	.....
11	61.5	45.0	51.2	.48	78.5	64.5	71.4	.....	90.8	76.5	81.7	.01	89.0	60.4	71.4	.....
12	50.0	44.0	46.2	.14	83.0	60.5	70.9	.....	90.2	70.1	79.4	.69	84.1	67.3	74.5	.18
13	50.5	43.0	47.2	.34	83.5	64.2	71.3	*—	85.0	71.8	76.9	.02	88.8	67.3	77.3	.....
14	53.5	48.3	51.0	.47	85.6	59.8	72.3	.....	83.5	67.4	74.8	*—	90.9	67.4	79.3	.....
15	58.3	49.1	53.3	.04	92.2	64.8	80.0	.....	84.8	63.6	74.1	.....	91.0	68.5	78.2	.....
16	60.1	48.4	53.8	.02	88.5	69.5	73.5	.33	87.6	64.6	77.0	.....	91.0	73.1	80.1	.21
17	71.0	46.8	60.3	*—	87.6	67.2	77.7	*—	85.3	66.7	77.5	.....	89.0	73.3	79.1	*—
18	63.1	47.8	54.2	*—	89.1	67.4	80.2	.....	86.0	68.3	77.1	.06	81.6	66.9	73.4	.....
19	66.6	46.9	55.8	.....	85.5	70.1	77.3	.01	88.0	69.4	77.0	.30	79.8	59.5	68.5	.....
20	77.0	50.0	63.7	.....	75.7	58.2	67.0	.....	88.5	67.6	77.0	.01	81.0	58.9	69.9	.....
21	82.9	54.9	72.2	*—	83.8	61.5	71.9	*—	81.5	68.0	74.5	*—	84.5	57.2	71.7	.....
22	80.0	61.9	69.0	.57	86.4	62.5	74.7	.....	81.8	66.9	71.9	*—	73.2	66.2	69.8	.12
23	70.8	53.9	60.0	.12	90.0	67.3	79.0	.....	86.5	63.6	75.2	.....	79.4	65.9	72.1	.23
24	72.7	52.4	63.2	.....	93.9	72.5	83.5	.....	90.2	66.8	77.3	.....	86.2	68.3	76.1	.01
25	64.1	52.2	57.2	.33	95.0	75.6	85.4	.....	93.8	65.0	79.9	.....	86.5	66.8	76.4	.....
26	70.0	45.3	59.1	.....	90.6	76.8	81.8	.02	94.5	68.6	82.4	.....	83.5	67.6	76.1	.36
27	83.2	52.8	68.8	1.11	88.7	69.4	76.9	.....	89.6	75.1	72.8	.17	80.5	68.6	74.6	.37
28	83.0	64.5	71.9	.19	89.1	65.4	76.6	.41	91.7	72.1	75.0	1.03	74.5	63.4	67.5	1.02
29	73.5	59.5	65.5	.....	87.5	71.9	76.5	.....	91.2	70.0	79.0	.02	76.7	57.2	66.7	.....
30	76.2	50.3	66.0	.....	83.7	64.9	73.8	.....	87.0	70.0	78.0	.....	76.2	55.9	66.9	.....
31	83.4	60.5	74.1	.03	......	......	......	.....	84.1	68.4	76.2	.....	76.5	63.2	71.0	.34

Statement showing the maximum, minimum, and mean temperatures and the precipitation, &c.—Continued.

Day of month.	1882. September. Temperature. Max.	Min.	Mean	Rain.	October. Temperature. Max.	Min.	Mean	Rain.	November. Temperature. Max.	Min.	Mean	Rain.	December. Temperature. Max.	Min.	Mean	Rain.
	°	°	°	*In.*	°	°	°	*In.*	°	°	°	*In.*	°	°	°	*In.*
1	86.7	66.7	77.8	....	76.0	56.5	64.8	.....	78.6	59.4	67.6	.12	45.0	25.3	36.8	.....
2	92.2	72.4	79.3	.....	74.0	53.0	62.0	.....	65.1	45.7	53.3	.54	54.0	28.0	42.3	.....
3	90.0	70.1	78.5	1.53	76.5	52.1	63.2	....	49.5	32.6	41.1	. .	44.2	26.0	29.3	.....
4	84.6	70.3	75.7	.01	73.6	54.1	63.4	*—	48.3	41.4	44.3	.01	37.0	19.5	30.7	.....
5	82.6	66.8	72.9	.....	76.9	53.9	64.9	.....	48.8	35.4	40.2	.....	49.5	34.5	44.3	.....
6	81.4	62.6	71.3	.	77.7	56.8	65.1	.....	49.4	29.6	40.7	.....	52.0	37.7	45.0	.....
7	82.2	62.9	73.2	.....	75.5	52.9	62.7	....	50.1	40.0	46.0	.03	39.5	10.5	23.6	.....
8	82.5	66.8	74.1	....	76.5	54.8	65.1	.....	58.9	43.2	49.1	. .	22.4	7.8	16.4	.....
9	77.1	65.0	70.7	....	81.3	58.7	68.5	.03	62.1	36.8	51.3	.08	34.8	12.4	27.4	.....
10	76.0	64.4	69.7	0.1	75.5	58.2	66.6	.....	65.1	52.1	57.2	.05	43.9	33.4	39.0	.34
11	73.0	61.0	66.5	1.85	78.5	58.1	66.0	.02	62.5	50.0	55.6	.....	39.9	29.7	35.4	.04
12	73.8	57.9	64.5	.02	59.4	55.0	57.7	.08	74.1	51.4	62.9	.	41.6	27.8	34.7	.....
13	75.5	51.6	65.8	.....	61.3	53.6	58.2	.02	70.8	40.6	52.2	.23	48.9	31.8	41.1	.45
14	84.3	62.0	74.8	.....	71.5	55.1	62.2	.....	45.5	34.8	39.6	.....	45.3	31.4	38.9	.....
15	79.5	66.0	72 0	....	72.2	49.9	59.4	.....	50.5	34.5	40.3	.....	38.0	24.3	26.9	.....
16	77.1	57.3	67.9		74.0	51.6	64.9	.02	54.0	31.5	43.9	.....	......	......	......	.....
17	83.5	59.7	70 8	.....	72.4	63.2	67.6	.04	52.5	42.5	46.7	.03	....	......	......	.....
18	83.5	63.5	73.8	.02	77.8	63.9	68.7	.....	45.0	37.5	39.3	.....	......	......	......	.....
19	90.5	66.6	78.7	....	64.4	57.0	60.8	.28	43.4	27.2	34.0	.....	......	......	......	.....
20	87.5	69.3	75.3	1.39	57.1	45.0	50.1	.....	45.8	30.8	38.1	.....	......	......	......	.....
21	83.7	66.0	74.6	.09	59.4	44.7	50.5	.....	44.5	25.0	33.7	.....	......	......	......	.....
22	74.1	63.7	69.6	.43	59.1	46.8	55.1	.....	48.6	28.0	36.6	.....	......	......	......	.....
23	67.2	57.3	61.6	.82	66.0	53.1	58.0	*—	54.1	27.0	41.3	.....	......	......	......	.....
24	70.1	53.4	63.0	.....	58.6	48.3	52.8	*—	44.1	33.0	39.1	.....	......	......	......	.....
25	62.6	57.1	58.8	.24	64.4	43.5	52.6	.....	42.0	30.0	34.8	....	......	......	......	.....
26	59.3	56.2	58.0	1.15	72.9	46.8	59.9	.....	40.0	26.0	34.2	.02	......	......	......	.....
27	59.6	55.4	56.9	.27	61.9	49.9	55.4	*—	43.3	31.0	38.0	.....	......	......	......	.....
28	63.1	51.2	56.0	.01	55.8	49.1	52.7	.01	32.0	25.5	28.1	.09	......	......	......	.....
29	71.8	44.5	58.2	. .	69.1	54.8	63.4	.03	33.4	24.0	29.8	.13	......	......	......	.....
30	75.1	49.8	62.0	.....	71.0	56.8	62.4	*—	36.0	26.0	29.0	.....	......	......	......	.....
31	......	......	......	.....	73.0	54.9	65.1	.....	.....	......	......	.....	......	......	......	.....

* The dash in the columns for rainfall indicates precipitation too small to measure.

Average temperature and rainfall from May 1 to December 15, 1882.

Month.	Average mean temperature.	Average daily rainfall.
	°	*Inches.*
May	59.2	.16
June	73.8	.08
July	76.0	.14
August	73.9	.14
September	69.1	.26
October	61.0	.02
November	42.9	.04
December	34.1	.06

Statement showing storms at Washington, D. C., between May 1 and December 15, 1882, in which the precipitation exceeded one inch.

[From the records on file at the office of the Chief Signal Officer, U. S. Army, Washington, D. C.]

Date.	Precipitation.	Date.	Precipitation.
May 27	1.11	August 27 and 28	1.21
May 31 to June 1	1.24	September 3 and 4	1.54
July 4	2.00	September 11	1.85
July 28 to 29	1.05	September 20 and 21	1.48
August 1 to 2	1.48	September 26	1.15

Statement showing all frosts at Washington, D. C., between May 1 *and December* 15, 1882.

[From the records on file at the office of the Chief Signal Officer, U. S. Army, Washington, D. C.]

Month.	Dates of frosts.
November	*3, 5, 6, 15, 16, 19, 21, 22, 23, 24, 26.
December	2, 4, 12.

* First of season.

Average temperature and rainfall from May 1 *to December* 15, 1882.

Month.	Average mean temperature.	Average daily rainfall.
	°	*Inches.*
May	59.2	.16
June	73.8	.08
July	76.0	.14
August	73.9	.14
September	69.1	.26
October	61.0	.02
November	42.9	.04
December	34.1	.06

Comparison of seasons 1880, 1881, 1882.

TEMPERATURE AND RAINFALL.

Month.	1880.		1881.		1882.	
	Mean monthly temperature.	Average daily rainfall.	Mean monthly temperature.	Average daily rainfall.	Mean monthly temperature.	Average daily temperature.
	°	*Inches.*	°	*Inches.*	°	*Inches.*
May	70.8	.11	67.9	.06	59.2	.16
June	74.8	.12	70.9	.19	73.8	.08
July	77.2	.07	77.4	.05	76.0	.14
August	75.1	.12	76.4	.03	73.9	.14
September	67.9	.11	77.0	.07	69.1	.26
October	55.4	.07	62.9	.11	61.0	.02
November	40.7	.08	47.5	.08	42.9	.04
December	....	....	....	....	34.1	.06

	1880.	1881.	1882.
Total rainfall, May and June ....inches	6.89	7.57	7.33
Total rainfall, July, August, and September ....do	9.37	4.93	16.74
Total rainfall, May to September, inclusive ....do	16.26	12.50	24.07
Average daily rainfall, May and June ....do	.113	.124	.120
Average daily rainfall, July, August, and September ....do	.102	.054	.182
Average mean temperature, May and June ....degrees	72.8	69.4	66.4
Average mean temperature, July, August, and September ....do	73.4	76.9	73.0
Average mean temperature, May to September, inclusive ....do	73.16	73.92	70.40

Frosts.

1880—October 1, 19, 25; November 1, 2, 3, 8, 9, 16.
1881—October 6, 11; November 14, 16, 17, 28, 29.
1882—November 3, 5, 6, 15, 16, 19, 21, 22, 23, 24, 26.

STORMS OVER ONE INCH OF RAINFALL.

	Inches.
1880— 6 in all, May to September inclusive, aggregating	9.99
1881— 3 in all, May to September inclusive, aggregating	4.87
1882—10 in all, May to September inclusive, aggregating	14.11

By reference to the above data, it will be seen that the past three seasons have been very unlike in their climatic conditions.

The contrast between the seasons of 1880 and 1881 was discussed upon page 456 of the annual report for 1881. The season of 1880 may fairly be regarded as an average one for this locality in regard to temperature and rainfall, while the season of 1881 was almost unprecedented for the severe drought. The total rainfall from May to September, inclusive, was 12.5 inches, while during the same period in 1882 it was 24.07 inches. In 1881 the number of storms during this period was only three, with an aggregate rainfall of only 4.87 inches, while in 1882 there were ten storms, with a rainfall of 14.11 inches. The average temperature for these five months (from planting to maturity of the crop) was, in 1881, 73.92°, while in 1882 it was only 70.40°.

It will also be observed that the first frost in 1882 was, notwithstanding the unusually cold season, a month later than in the two preceding years.

The lack of rain during October, 1882, and a temperature for the month much above the average for the past two years, together with absence of frost, gave an additional month for the maturity of the sorghums, and this in part made up for the late planting and unfavorable season.

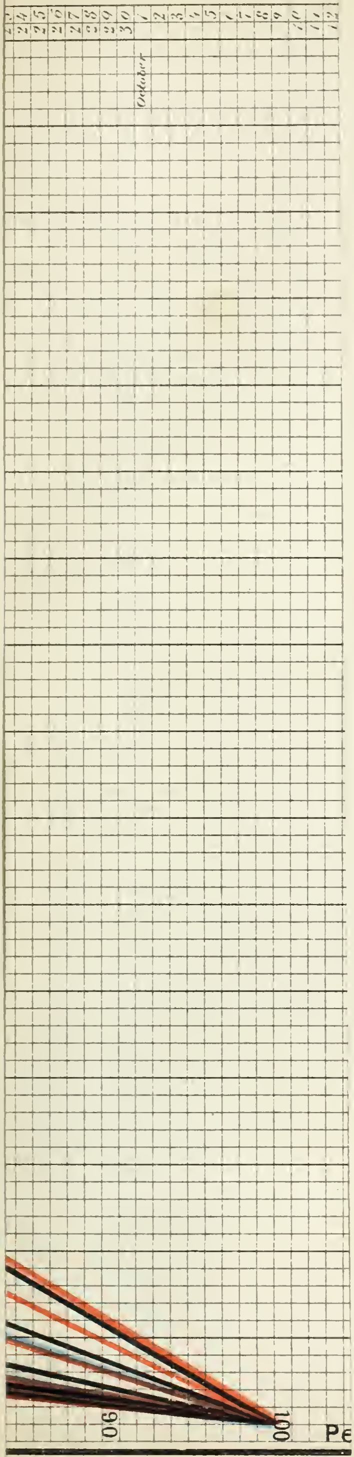
AVERAGE RESULTS OF ANALYSES OF SORGHUM AT DIFFERENT STAGES.

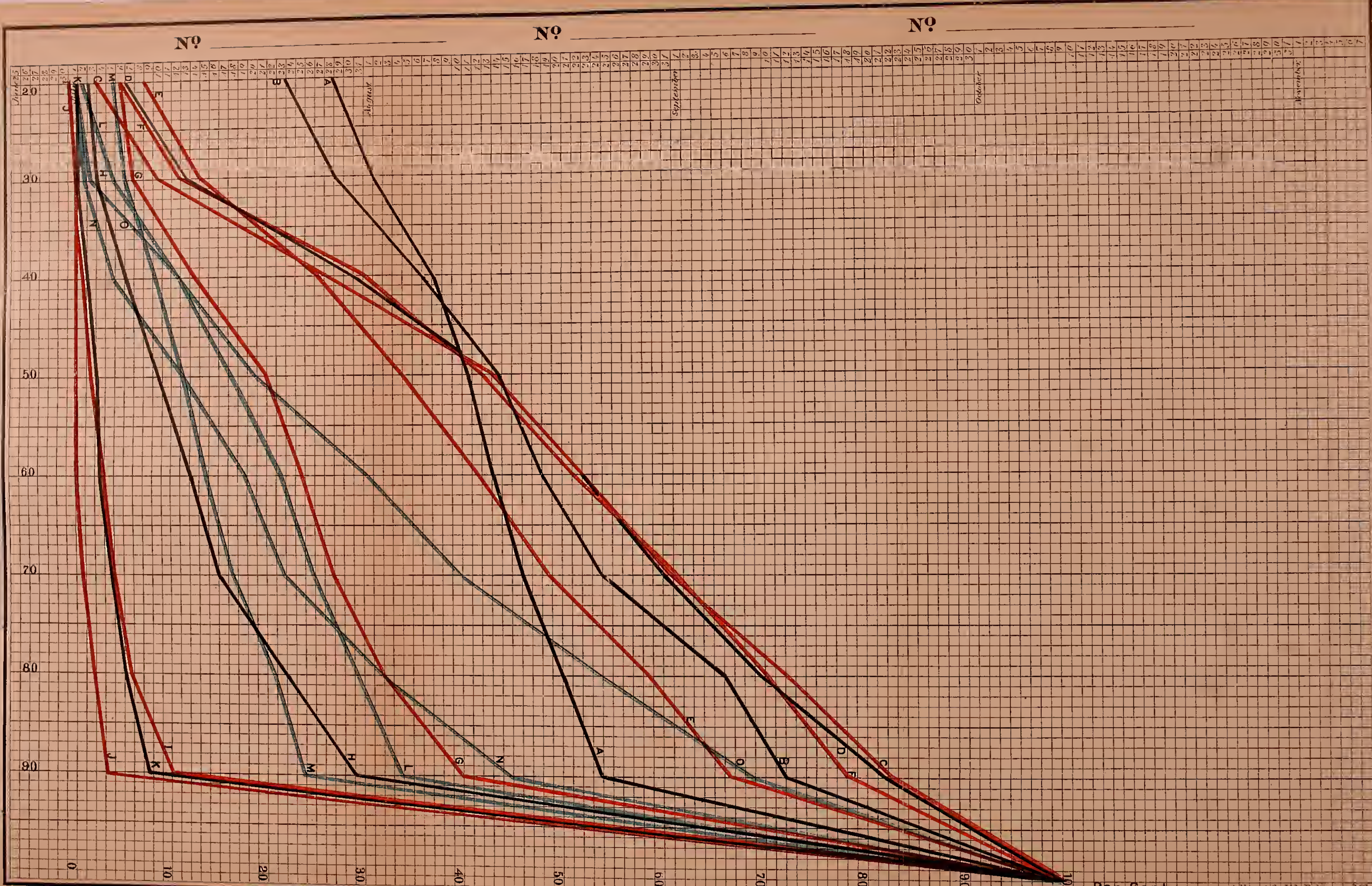
From the results of the analyses of the past season the following table has been prepared, giving the average result of the analyses of all the sorghums at the different stages of their development. The same results are graphically represented on the accompanying chart.

By reference to page 452, Annual Report Department of Agriculture, 1881, the general averages for the years 1879, 1880, 1881, and of the three years together, may be found.

It will be seen by comparing the results obtained this year by the examination of these many varieties, wholly new to this country, that the agreement is remarkably close.

Nº ____________




Nº
Nº
Nº
June
August
September
October
November
20
30
40
50
60
70
80
90
0
10
20
30
40
50
60
70
80
90
100
Per Cent.
A B C D E F G H J K L M N O
A. Hoen & Co. Lith. Baltimore, Md.

Average results of analyses at different stages of development.

No. of analysis.	Development.	Per cent. of juice.	Specific gravity.	Per cent. glucose.	Per cent. sucrose.	Per cent. solids.	Polarization.	Per cent. available sugar.
2	Head swelling	66.97	1.034	3.255	3.78	1.275	3.98	−0.75
4	Head fully out	63.04	1.040	4.398	3.85	1.265	4.195	−1.813
2	Before bloom	60.22	1.044	4.59	5.14	1.50	5.77	−0.95
6	In full bloom	63.90	1.049	3.89	6.47	1.67	6.64	0.88
21	After bloom	63.77	1.050	3.32	7.38	2.17	6.56	1.85
85	Seed in milk	60.88	1.055	2.90	8.45	2.41	8.87	3.20
187	Seed in dough	58.11	1.0606	2.171	9.88	2.656	9.80	5.054
206	Seed hard	58.07	1.0627	1.33	10.48	2.885	10.447	6.233
94	Sucker seed in milk	56.71	1.0668	1.203	11.448	3.274	11.603	7.426
199	Sucker seed in dough	58.06	1.070	1.12	12.25	3.10	12.40	8.19
134	Sucker seed hard	52.90	1.0731	1.45	12.63	3.52	12.33	8.56

AVERAGE RESULT OF ANALYSES OF SORGHUM JUICES AT DIFFERENT SPECIFIC GRAVITIES.

In the following table is given the average composition of the juices of the several varieties of sorghum grown this year, at different specific gravities.

For comparison, reference is made to a similar table giving the results obtained in the season of 1881.—(Department of Agriculture, Annual Report, 1881, page 469.)

It will be found that although for the greater part the varieties under examination were entirely different, and the two seasons in their climatic character and condition widely unlike, the two tables give very closely accordant results, thus confirming the opinion that the character of the crop may be very closely determined by the specific gravity of the juice, both as to its value for sugar and sirup:

Average results of analyses of sorghum juices at different specific gravities.

Number of analysis.	Specific gravity.	Per cent. juice.	Per cent. glucose.	Per cent. sucrose.	Per cent. solids.	Polarization.	Per cent. available sugar.
1	1.015	59.51	0.25	0.51	2.78	0.55	— 2.52
1	20	59.26	0.26	1.41	2.89	1.26	— 1.74
1	26	57.34	2.02	1.70	2.46	1.81	— 2.78
2	27	62.23	1.27	2.63	2.38	2.19	— 1.02
1	28	55.33	0.39	3.05	2.86	2.16	— 0.20
2	1.030	51.84	1.38	3.43	2.28	3.21	— 0.22
1	31	71.30	1.10	3.00	2.76	3.04	— 0.86
2	32	56.45	1.86	3.39	3.30	....	— 1.77
2	33	61.45	1.37	4.25	2.76	3.74	— 0.02
3	34	54.16	1.30	3.78	2.79	3.69	— 0.32
2	35	66.45	3.36	3.03	1.81	3.10	— 2.14
1	36	62.36	3.91	4.13	1.58	....	— 1.36
2	37	65.60	3.49	3.55	2.12	3.55	— 2.06
3	38	64.39	2.41	4.95	1.87	4.85	0.66
5	39	61.91	1.94	4.47	2.73	4.74	— 0.19
2	1.040	67.63	3.49	4.93	1.30	4.42	0.15
5	41	62.35	2.79	4.84	2.42	4.11	— 0.37
8	42	59.51	3.19	4.47	2.33	4.52	— 0.93
3	43	50.30	1.13	5.43	3.63	5.59	0.67
3	44	65.04	3.51	5.82	1.65	5.06	0.66
6	45	55.90	1.88	6.44	2.66	5.95	1.91
9	46	53.86	2.91	6.09	2.30	5.43	0.88
7	47	62.80	2.98	6.22	3.15	6.29	0.09
11	48	60.70	2.34	7.02	2.66	7.05	2.02
9	49	56.16	3.00	6.57	2.76	5.99	0.81
11	1.050	54.94	2.45	6.86	2.83	6.64	1.59
14	51	57.74	2.53	7.83	2.38	7.05	3.17
17	52	56.16	1.69	8.23	2.84	7.92	3.69

Average results of analyses of sorghum juices, &c.—Continued.

Number of analysis.	Specific gravity.	Per cent. juice.	Per cent. glucose.	Per cent. sucrose.	Per cent. solids.	Polarization.	Per cent. available sugar.
19	53	55. 58	2. 33	8. 19	2. 48	7. 85	3. 38
18	54	58. 55	2. 29	8. 19	2. 42	7. 92	3. 47
21	55	57. 38	2. 75	8. 09	2. 32	7. 72	3. 12
30	56	58. 19	1. 99	8. 58	2. 78	8. 54	3. 80
35	57	57. 71	1. 75	8. 91	2. 88	8. 90	4. 29
25	58	57. 70	1. 98	9. 31	2. 65	9. 39	4. 68
18	59	56. 85	1. 78	9. 45	3. 02	9. 40	4. 64
28	1. 060	51. 18	2. 02	9. 84	2. 74	9. 80	5. 24
25	61	55. 39	1. 98	9. 75	2. 83	9. 95	4. 53
29	62	55. 87	1. 87	10. 26	2. 61	10. 08	5. 83
30	63	58. 44	1. 66	10. 59	2. 87	10. 50	6. 04
38	64	59. 11	1. 46	10. 73	2 83	10. 72	6. 83
30	65	56. 38	1. 62	10. 97	2. 91	10. 96	6. 44
36	66	56. 62	1. 47	11. 32	2. 84	11. 19	6. 73
36	67	58. 81	1. 35	11. 50	3. 02	12. 29	7. 12
31	68	59. 67	1. 54	11. 80	2. 71	11. 79	7. 55
53	69	58. 37	1. 50	12. 19	2. 73	12. 06	7. 95
29	1. 070	58. 13	1. 40	12. 23	3. 03	12. 13	7. 94
33	71	57. 38	1. 07	12. 75	3. 09	12. 86	8. 29
40	72	57. 08	1. 40	12. 76	2. 87	12. 57	8. 50
46	73	58. 12	1. 22	13. 18	2. 91	13. 02	9. 05
37	74	56. 18	1. 57	13. 09	2. 58	12. 90	8 67
31	75	57. 49	1. 10	13 50	3. 27	13. 41	9. 13
32	76	56. 17	1. 36	13. 39	2. 89	13. 15	8. 82
26	77	57. 59	1. 12	13. 76	3. 27	13. 79	9. 38
24	78	55. 98	1. 40	13. 71	3. 08	13. 69	9. 23
18	79	55. 39	1. 00	14. 16	3. 17	14. 06	9. 99
14	1. 080	53. 25	0. 97	14. 53	3. 13	14. 38	10. 39
9	81	53. 49	1. 03	14. 52	2. 98	14. 53	10. 51
10	82	52. 68	1. 38	14. 64	2. 78	13. 23	10. 44
12	83	48. 45	1. 55	14. 24	3. 15	13. 88	9. 56
2	83	52. 29	1. 01	15. 30	3. 12	14. 72	11. 18
5	85	47. 94	1. 63	14. 29	3. 47	14. 05	9. 20
1	86	52. 00	0. 74	15. 68	3. 41	15. 44	11. 53
1	87	48. 88	0. 62	15. 36	3. 78	15. 57	10. 96
1	89	42. 16	1. 95	14. 96	3. 16	13. 94	9. 85
1	1. 090	42. 50	2. 03	15. 57	2. 94	15. 12	10. 60
1	91	43. 40	2. 53	14. 98	3. 00	13. 81	9. 45
1	92	42. 54	1. 96	15. 34	3. 08	14. 40	10. 30
1	93	37. 13	2. 82	14. 97	3. 09	....	9. 06
1	95	39. 25	3. 34	15. 17	2. 61	13. 72	9. 22
1	1. 105	35. 01	2. 33	17. 19	3. 67	....	11. 19

EFFECT OF REMOVING SEED DURING DEVELOPMENT OF PLANT

During the experiments upon sorghums grown on the grounds of the Department for the past five years, much annoyance has been occasioned by the multitude of English sparrows, and it was almost impossible to save any seed from the crop except of such varieties as appeared less attractive to these birds, or from such panicles as were protected against their invasions. It was at least a matter of doubt whether this removal of the seed during the plant's development had not had an effect upon the sugar content of the juices, since, as is obvious, the production of the seed is at the expense of constituents of the juice of the plant; and if this process is arrested by the removal of the seed before reaching maturity, it would appear natural to expect some result upon analysis of the juices of such plants.

That such a view has widely obtained, among those engaged in the investigation of the production of sugar from sorghum and maize stalks, is clear, from the advice frequently given to remove the ears of corn so soon as they appear, if the maximum amount of sugar in the juice from the stalks is desired. For the purpose of securing the seed of the new

varieties from Africa, India, and China, as also to learn whether to any extent our results in past years had been vitiated by these depredations of the birds, care was taken this season to protect certain panicles of each variety grown, so soon as they came into blossom, by enveloping them in bags made of tarlatan. In this way we were able to secure well-developed heads of each, fully set with seed.

In the examinations made there were taken for analysis one stalk, the panicle of which had been thus protected, and another at the same time of the same variety, and so far as other indications showed, at the same stage of development, but the seed of which had been taken by the birds.

There were made during the season in all 136 pairs of analyses of most of the varieties under examination. The results of these analyses are given upon the following tables. Those analyses which in the tables already given are marked with a star (*), and in the tables following are so marked, are of the juices of those stalks the panicles of which had been protected.

Effect of removing seed during

SEED REMOVED.

No. of analysis.	Variety.	Development.	Per cent. juice.	Specific gravity.	Per cent. glucose.	Per cent. sucrose.	Per cent. solids.	Polarization.	Per cent. available sugar.
428	9 A. Iyangentembi..	Seed hard.............	56.37	1.079	0.65	14.12	3.70	14.54	9.74
431	12. Dindemuka	Seed hard, sucker in dough.	64.80	1.064	0.86	11.21	2.96	11.69	7.39
433	13. Uboyana........	Seed hard..............	65.36	1.054	2.44	8.00	0.57	7.95	4.99
438	16 A. Ufatane	......do	60.75	1.078	1.58	13.60	3.08	13.52	8.94
442	16 C. Ufatane	......do	59.21	1.076	0.99	14.45	2.46	14.00	11.00
444	17 A. Unkunjana ...	Seed in dough	57.05	1.076	0.56	14.65	3.82	13.77	10.27
446	17 B. Unkunjana ..	Seed hard.............	59.56	1.074	0.86	14.33	2.27	13.46	11.20
450	18 A. Alongonde ..	Seed hard, sucker after bloom.	66.04	1.069	1.94	11.65	3.25	11.82	6.46
452	18 B. Alongonde ..	Seed hard..............	60.19	1.071	0.99	12.63	3.35	13.38	8.29
457	3 A. San Sui Pai Liang.	......do	43.82	1.057	0.63	8.04	4.09	7.66	3.32
459	3 B. San Sui Pai Liang.	Seed hard, sucker after bloom.	36.28	1.071	0.93	12.09	4.13	13.23	7.03
461	4. Er Chin Aung Liang.	Seed hard..............	41.37	1.067	0.35	11.53	4.22	11.65	6.96
463	5. Ma Wei Nien Liang.	Seed hard, sucker in milk.	40.35	1.067	0.69	10.12	4.46	10.43	4.97
465	6. Ta Min Hung Liang.	Seed hard, sucker after bloom.	....	1.054	0.57	8.20	3.65	8.62	3.98
470	21. White African..	Seed hard, sucker in milk.	59.87	1.070	1.03	12.23	2.60	12.22	8.60
472	22. White Mammoth	......do	57.12	1.071	1.05	11.05	4.49	12.89	5.51
474	23. West Indian	......do	61.58	1.076	2.04	12.40	2.90	12.61	7.46
484	27. Bear Tail.........	Seed hard, sucker in dough.	57.28	1.068	1.80	12.01	2.23	11.75	7.98
486	29 A. Black Sorgho.	......do	58.91	1.070	0.60	10.75	4.66	12.26	5.49
490	31. Link's Hybrid ..	Seed hard, sucker in milk.	59.73	1.079	0.55	14.96	2.77	14.94	11.64
492	32. Standard Harrell	Seed hard, sucker in dough.	58.84	1.081	0.44	15.16	3.41	15.58	11.35
496	34. Gray Tops	......do	61.63	1.069	0.82	12.60	2.76	12.54	9.02
506	38. New Variety, Harwell.	Seed hard, sucker in milk.	63.24	1.074	1.00	12.98	3.27	13.20	8.71
508	39. Chinese Imphee.	......do	59.09	1.067	0.68	12.02	2.75	11.95	8.59
510	40 A. New Variety, Bradford.	......do	53.22	1.071	0.57	12.72	3.63	12.59	8.52
512	7. Undendebule.....	......do	60.27	1.081	0.52	14.48	3.81	14.76	10.15
523	13. Uboyana.........	Seed hard..............	65.00	1.067	1.31	12.11	2.30	11.84	8.50
526	15 A. Ubehlana.....	Seed hard, sucker in bloom.	59.56	1.081	1.46	14.80	2.41	14.72	10.93
528	16 A. Ufatane	......do	58.68	1.073	1.64	14.00	1.12	12.70	11.24
533	16 B. Ufatane.......	Seed hard..............	61.65	1.078	0.90	13.66	3.38	15.43	11.15
535	16 C. Ufatane.......	......do	60.34	1.077	0.93	13.80	3.24	13.87	9.70
537	17 A. Unkunjana...	Seed hard, sucker in bloom.	59.74	1.062	1.95	10.00	0.38	9.99	7.67
539	17 B. Unkunjana ...	Seed hard..............	59.08	1.065	0.95	11.60	2.96	11.71	7.69
541	17 C. Unkunjana ...	......do	61.12	1.068	1.04	12.04	3.03	12.40	7.97
543	18 A. Algonde	Seed hard, sucker in milk.	63.14	1.068	1.40	12.44	2.34	11.66	8.70
545	18 B. Algonde	Seed in dough	....	1.077	1.01	13.51	3.35	13.20	9.15
548	2. San Sui Hong Laing.	Seed hard, sucker in milk.	65.76	1.064	0.51	10.93	3.98	10.54	6.44
550	3 A. San Sui Pai Laing.	Seed hard..............	50.17	1.073	0.75	13.21	2.83	12.96	9.63
552	3. B. San Sui Pai Laing.	Seed hard, sucker in milk.	52.33	1.071	0.74	12.34	3.28	11.99	8.32
554	4. Er Chin Hung Laing.	......do	43.73	1.064	0.66	10.63	3.47	10.50	6.50
556	5. Ma Wei Nien Laing.	......do	32.34	1.061	0.70	9.61	3.53	....	5.38
558	6. Ta Min Hung Laing.	Seed hard, sucker in bloom.	18.83	1.063	0.71	10.30	3.51	....	6.08
608	22. White Mammoth	Seed hard, sucker in dough.	59.06	1.074	0.85	13.69	2.44	14.51	10.40
610	23. West Indian	Seed hard, sucker in milk.	57.23	1.071	2.18	11.94	2.52	11.68	7.24
616	27. Bear Tail........	Seed hard, sucker in dough.	62.27	1.064	1.67	11.60	2.22	11.19	7.71
625	32. Standard Harrell	......do	61.27	1.075	0.60	14.12	2.91	14.31	10.61

development of plant.

SEED PRESERVED.

No. of analysis.	Variety.	Development.	Per cent. juice.	Specific gravity.	Per cent. glucose.	Per cent. sucrose.	Per cent. solids.	Polarization.	Per cent. available sugar.
429	9 A. Iyangentembi	Seed hard	61.20	1.073	0.89	13.48	2.97	13.51	9.62
432	12. Dendemuka	Seed head, sucker in dough.	62.96	1.059	1.20	9.62	2.84	9.94	5.58
434	13. Uboyana	Seed in dough	66.91	1.046	2.77	6.56	3.26	6.60	0.53
439	16 A. Ufatane	do	60.32	1.052	0.56	9.34	7.51	8.33	1.27
443	16 C. Ufatane	do	59.23	1.053	1.22	9.62	6.76	8.84	1.64
445	17 A. Unkunjana	do	61.81	1.055	2.12	10.23	1.07	8.79	7.04
447	17 B. Unkunjana	Seed hard	66.74	1.058	1.30	9.67	2.84	9.68	5.53
451	18 A. Alogonde	Seed in dough	65.82	1.054	2.56	8.09	2.30	8.26	3.23
453	18 B. Alogonde	Seed hard	64.85	1.065	1.39	10.91	3.16	11.49	6.36
458	3 A. San Sui Pai Lang.	do	43.22	1.042	0.54	4.94	4.02	5.15	0.28
460	3 B. San Sui Pai Lang.	do	43.54	1.061	0.47	9.33	4.65	9.54	4.21
462	4. Er Chin Hung Liang.	Seed hard, sucker in bloom.	44.12	1.056	0.39	8.62	4.97	8.38	4.26
464	5. Ma Wei Nien Liang.	do	37.85	1.066	0.69	9.59	4.77	9.70	4.13
466	6. Ta Min Hung Liang.	Seed hard, sucker in milk.	45.41	1.051	0.43	6.83	4.27	6.66	2.13
471	21. White African	Seed in dough	61.36	1.058	1.62	9.74	2.47	9.40	5.65
473	22. White Mammoth	Seed hard	63.53	1.053	2.30	7.95	2.48	7.54	3.17
475	23. West Indian	Seed in dough	60.61	1.066	3.46	9.38	2.48	8.74	3.44
485	27. Bear Tail	Seed hard	57.82	1.057	2.25	8.12	2.24	7.47	3.63
487	29 A. Black Sorgho	do	58.93	1.052	1.07	7.75	3.14	7.39	3.54
491	31. Link's Hybrid	Seed hard, sucker in milk.	61.30	1.071	0.68	13.62	2.40	13.27	10.54
493	32. Standard Harrell	do	58.04	1.071	0.62	13.73	2.66	13.34	10.45
497	34. Gray Tops	Seed hard	63.76	1.052	1.92	8.26	2.12	7.70	4.22
507	38. New Variety, Harwell.	do	62.67	1.061	1.70	9.38	3.11	9.27	4.57
509	Chinese Imphee	do	66.73	1.067	0.83	10.09	2.53	9.79	6.73
511	40 A. New Variety, Bradford.	Seed hard, sucker in milk.	67.12	1.054	2.62	8.24	2.22	7.80	3.40
513	7. Undendebule	do	61.28	1.073	0.68	13.31	5.25	13.17	7.38
524	13. Uboyana	Seed hard	64.90	1.057	1.29	10.35	1.77	9.84	7.29
527	15 A. Ubehlana	do	76.12	1.068	0.75	11.68	3.02	11.37	7.91
529	16 A. Ufatane	do	60.67	1.057	0.80	10.27	2.43	10.30	7.04
534	16 B. Ufatane	Seed in dough	63.78	1.066	1.23	11.62	1.61	11.59	8.75
536	16 C. Ufatane	do	60.91	1.052	1.17	8.54	2.59	8.39	4.63
538	17 A. Unkunjana	do	63.39	1.049	2.38	7.20	2.36	7.14	2.46
540	17 B. Unkunjana	Seed hard	62.22	1.052	1.43	8.89	2.38	8.47	5.08
542	17 C. Unkunjana	Seed in dough	66.23	1.050	1.43	8.38	2.55	8.33	4.36
544	18 A. Alongonde	do	61.63	1.063	1.88	9.85	3.20	9.60	4.77
546	18 B. Alongonde	do	61.83	1.064	1.48	10.85	2.88	10.67	6.49
549	2. San Sui Hung Liang.	Seed hard, sucker in bloom.	39.54	1.061	0.72	9.40	3.91	8.60	4.77
551	3 A. San Sui Pai Liang.	Seed hard	42.30	1.052	0.52	6.91	4.08	6.54	2.31
553	3 B. San Sui Pai Liang.	Seed hard, sucker in milk.	62.36	1.063	1.79	10.55	2.68	10.06	6.08
555	4. Er Chin Hung Liang.	do	41.16	1.057	0.32	8.26	4.21	7.81	3.73
557	5. Ma Wei Nien Liang.	Seed hard, sucker in bloom.	34.58	1.053	0.45	7.71	4.23	......	3.03
559	6. Ta Min Hung Liang.	Seed hard	48.58	1.054	0.58	7.94	3.69	7.45	3.67
609	22. White Mammoth	do	60.21	1.058	1.61	10.03	2.25	9.68	6.17
611	23. West Indian	Seed hard, sucker in milk.	59.79	1.055	4.82	6.54	1.88	5.45	−0.16
617	27. Bear Tail	Seed hard	56.45	1.058	1.36	10.34	2.55	13.61	6.43
626	32. Standard Harrell	Seed hard, sucker in dough.	60.71	1.068	0.54	13.12	2.64	12.78	9.94

Effect of removing seed during

SEED REMOVED—Continued.

No. of analysis.	Variety.	Development.	Per cent. juice.	Specific gravity.	Per cent. glucose.	Per cent. sucrose.	Per cent. solids.	Polarization.	Per cent. available sugar.
629	34. Gray Tops	do	66.59	1.070	0.82	13.20	2.58	12.90	9.80
637	38. New Variety, Harwell.	do	41.36	1.066	1.13	11.66	2.59	11.40	7.94
641	40 A. New Variety, Bradford.	do	23.53	1.065	1.16	11.79	2.41	11.40	8.22
645	7. Undendebule	Seed hard, sucker in milk.	58.01	1.083	0.58	15.09	3.26	14.90	11.25
650	13. Uboyana	Seed hard, sucker in germ.	60.10	1.076	1.82	13.48	2.42	12.98	9.24
655	16 A. Ufatane	Seed hard, sucker in milk.	53.51	1.071	0.43	13.23	3.22	13.10	9.58
657	16 B. Ufatane	Seed hard	60.91	1.075	1.01	13.09	3.05	12.73	9.03
659	16 C. Ufatane	do	59.60	1.079	0.87	14.16	3.08	13.64	10.21
669	3 A. San Sui Pai Liang.	Seed hard, sucker after bloom.	57.83	1.069	1.89	12.11	2.07	....	8.15
671	3 B. San Sui Pai Liang.	Seed hard, sucker seed in milk.	43.96	1.066	0.82	10.67	3.63	....	6.22
673	4. Er Chin Hung Liang.	do	41.81	1.065	0.74	10.02	3.98	....	5.30
681	21. White African	Seed hard, sucker seed in dough.	59.45	1.075	0.86	13.72	2.02	....	10.84
679	17 C. Unkunjana	Seed hard	59.67	1.066	1.13	11.85	2.46	....	8.26
685	25. Early Amber	Seed hard, sucker seed hard.	57.34	1.075	1.38	13.07	3.03	....	8.66
687	27. Bear Tail	do	56.81	1.080	0.90	15.06	2.71	....	11.45
689	30. Red Sorgho	Seed hard, sucker seed in dough.	59.12	1.073	0.82	13.53	2.78	13.37	9.93
700	37. New Variety, E. Link.	do	50.83	1.083	0.93	15.05	3.20	15.03	10.92
754	13. Uboyana	Seed hard	62.27	1.064	2.13	10.59	2.34	10.08	6.12
757	15 A. Ubehlana	do	63.26	1.066	1.09	12.02	2.35	11.58	8.58
764	16 A. Ufatane	Seed hard, sucker seed in dough.	57.88	1.069	1.58	11.90	......	11.74	......
769	17 A. Unkunjana	do	53.02	1.060	2.71	9.61	1.83	9.57	5.07
771	17 C. Unkunjana	Seed hard	59.59	1.073	1.05	13.61	2.49	13 08	10.07
774	18 A. Alogonde	Seed hard, sucker seed in dough.	57.73	1.072	0.75	13.80	2.44	13.15	10.61
776	18 B. Alogonde	Seed hard	58.53	1.074	2.25	13.43	1.72	....	9.46
785	3 B. San Sui Pai Liang.	Seed hard, sucker seed in milk.	29.52	1.062	0.77	9.07	4.69	....	3.61
791	21. White African	Seed hard, sucker seed in dough.	60.40	1.062	2.02	10.96	2.01	10.14	6.93
799	27. Bear Tail	Seed hard, sucker seed hard.	57.21	1.075	0.13	14.17	2.81	13.60	11.23
801	30. Red Sorgho	Seed hard, sucker seed in dough.	63.28	1.074	1.64	13.74	1.95	13.50	10.15
803	32. Standard Harrell.	do	53.05	1.082	0.46	15.28	3.49	15.37	11.33
814	37. New variety, E. Link.	do	52.00	1.086	0.74	15.68	3.41	15.44	11.53
816	38. New variety, Haswell.	do	59.24	1.073	1.30	12.66	2.97	12.70	8.39
818	39. Chinese Imphee.	do	52.37	1.083	1.19	15.01	2.88	14.60	10.94
825	7. Undendebule	do	53.46	1.083	0.47	13.72	4.74	14.92	8.51
833	8 A. Ukubane	do	58.05	1.072	1.25	12.98	2.68	12.63	9.05
831	13. Uboyana	do	62.54	1.079	1.05	14.71	3.52	14.64	10.14
843	16 A. Ufatane	Seed hard	59.63	1.082	0.92	15.39	2.61	15.07	11.86
848	17 C. Unkunjana	do	61.02	1.061	1.25	10.87	2.07	10.33	7.55
850	18 A. Alogonde	Seed hard, sucker seed in hard dough.	59.44	1.082	1.83	14.05	2.85	13.90	9.37
857	18 B. Alogonde	do	58.82	1.072	1.19	13.47	2.28	13.37	10.00
860	4 Er Chin Hung Liang.	do	34.22	1.069	0.75	10.71	4.66	10.87	5.30
873	30. Red Sorgho	do	59.83	1.074	0.90	13.74	2.86	13.71	9.93
875	32. Standard Harrell	do	57.65	1.079	0.52	14.56	3.03	14.92	11.01
877	33. Neeazana	Seed hard, sucker seed hard.	52.37	1.077	1.82	13.68	2.88	13.44	8.98
886	35. White Liberian Nesbit.	do	47.02	1.072	1.04	12.57	3.41	12.18	8.12

development of plant—Continued.

SEED PRESERVED—Continued.

No. of analysis.	Variety.	Development.	Per cent. juice.	Specific gravity.	Per cent. glucose.	Per cent. sucrose.	Per cent. solids.	Polarization.	Per cent. available sugar.
630	34. Gray Top	Seed hard	61.44	1.057	1.82	8.74	2.79	8.22	4.13
638	38. New Variety, Harwell.	do	60.41	1.061	1.70	9.85	2.93	9.46	5.22
642	40 A. New Variety, Bradford.	Seed hard, sucker in dough.	66.58	1 057	2.54	8.34	1.75	8.31	4.05
646	7. Undendebule	Seed hard	58.21	1.074	0.70	12.84	3.35	12.44	8.79
651	13. Uboyana	do	65.03	1.052	1.32	9.15	2.10	8.65	5.73
656	16 A. Ufatane	do	61.87	1.065	1.84	10.74	2.39	10.11	6.51
658	16 B. Ufatane	Seed in dough	63.76	1.064	1.24	7.40	2.19	7.16	3.97
660	16 C. Ufatane	Seed hard	64.00	1.063	1.66	10.87	2.22	10.25	6.99
670	3 A. San Sui Pai Liang.	do	36.15	1.059	0.59	9.15	3.43	......	5.13
672	3 B. San Sui Pai Liang.	do	45.35	1.043	0.50	5.71	3.16	......	2.05
674	4. Er Chin Hung Liang.	do	38.41	1.055	0.57	8.13	3.80	......	3.76
682	21. White African	Seed in dough	59.24	1.069	1.31	11.84	2.93	......	7.60
680	17 C. Unkunjana	do	64.89	1.055	1.52	9.03	2.54	......	4.97
686	25. Early Amber	Seed hard, sucker seed hard.	55.71	1.057	1.93	8.58	2.96	......	3.69
688	27. Bear Tail	Seed hard	64.38	1.056	1.94	9.33	2.48	......	4.91
690	30. Red Sorgho	Seed in dough	64.67	1.063	2.58	10.64	1.76	9.96	6.30
701	37. New Variety, E. Link.	Seed hard	60.10	1.078	1.90	11.67	2.39	11.40	7.38
755	13. Uboyana	do	64.25	1.057	3.20	8.12	2.20	7.52	2.72
758	15 A. Ubehlana	do	57.45	1.068	0.83	11.60	3.22	11.17	7.55
765	16 A. Ufatane	do	63.86	1.063	2.01	10.60	2.75	10.15	5.84
767	17 A. Unkunjana	do	65.36	1.057	2.28	8.95	2.11	8.35	4.56
770	17 C. Unkunjana	do	65.56	1.071	1.23	12.90	2.37	12.67	9.30
775	18 A. Alogonde	do	63.58	1.064	1.27	11.05	2.60	10.47	7.18
777	18 B. Alogonde	do	61.05	1.066	2.15	11.37	2.18	......	7.04
786	3 B. San Sui Pai Liang.	do	37.39	1.054	0.43	7.71	4.16	......	3.12
792	21. White African	do	61.46	1.058	1.57	10.02	2.24	9.13	6.21
800	27. Bear Tail	Seed hard, sucker seed hard.	58.36	1.033	1.60	4.61	......	3.80	......
802	30. Red Sorgho	Seed hard	62.34	1.065	2.38	11.30	2.30	10.80	6.62
804	32. Standard Harrell.	Seed hard, sucker seed in dough.	47.41	1.073	0.68	13.41	3.19	13.08	9.54
815	37. New Variety, E. Link.	Seed hard	56.42	1.073	1.33	13.39	2.64	12.76	9.42
817	38. New Variety Haswell.	do	57.62	1.065	1.37	10.76	3.02	10.04	6.37
819	39. Chinese imphee	do	57.43	1.066	1.41	11.70	2.56	11.02	7.71
826	7. Undendebule	do	52.58	1.074	0.71	12.70	3.15	12.16	8.84
827	8 A. Ukubane	Seed hard, sucker seed in hard dough.	59.52	1.067	1.70	11.92	2.38	11.65	7.84
832	13. Uboyana	Seed hard	63.99	1.073	0.94	13.53	2.75	13.17	9.84
844	16 A. Ufatane	do	51.16	1.056	0.79	9.73	2.36	9.39	6.58
849	17 C. Unkunjana	do	64.88	1.053	1.84	8.40	2.11	8.06	4.45
856	18 A. Alogonde	Seed hard, sucker seed in hard dough.	62.50	1.076	1.52	11.65	4.58	13.24	5.55
858	18 B. Alogonde	Seed hard	62.02	1.071	0.93	12.99	2.83	12.74	9.23
861	4. Er Chin Hung Liang.	do	35.20	1.059	0 45	9.60	3.60	9.56	5.55
874	30. Red Sorgho	Seed hard, sucker seed in milk.	58.73	1.072	1.41	12.88	2.71	12.86	8.76
876	32. Standard Harrell.	Seed hard, sucker seed in hard dough.	54.04	1.069	0.67	12.48	3.10	12.45	8.71
878	33. Neeazana	Seed hard, sucker seed hard.	48.62	1.071	2.05	12.11	2.76	11.87	7.30
880	35. White Liberian Nesbit.	Seed hard, sucker seed in hard dough.	52.43	1.060	1.31	9.95	2.49	9.97	6.15

Effect of removing seed during

SEED REMOVED—Continued.

No. of analysis.	Variety.	Development.	Per cent. juice.	Specific gravity.	Per cent. glucose.	Per cent. sucrose.	Per cent. solids.	Polarization.	Per cent. available sugar.
891	7. Undendebule	Seed hard, sucker seed in hard dough.	59. 61	1. 078	0. 64	14. 44	3. 38	14. 61	10. 42
907	16 A. Ufatane	Seed hard............	63. 07	1. 073	1. 26	13. 13	2. 62	12. 68	9. 25
	Total	....	5019. 74	6. 595	89. 08	1164. 64	270. 95	1031. 48	787. 13
	Average	....	55. 775	1. 0717	. 968	12. 659	2. 978	12. 734	8. 650

Average development: 10. 42. Stage: Indian head Afric bloom and sucker seed in milk.

424	7. Undendebule	Seed hard, sucker in milk.	62. 50	1. 075	0. 78	13. 62	3. 23	13. 88	9. 61
426	8 A. Ukubane	......do	64. 90	1. 056	1. 96	9. 78	2. 24	9. 65	5. 58
436	15. Ubehlana	Seed hard.............	63. 85	1. 077	1. 71	13. 34	2. 76	13. 61	8. 87
440	16 B. Ufatane	Seed in dough	61. 60	1. 069	1. 51	11. 96	2. 75	12. 09	7. 70
448	17 C. Unkunjane ...	......do	64. 57	1. 050	3. 30	6. 50	3. 03	6. 25	0. 17
455	2. San Sin Hoong Liang.	Seed hard, sucker in milk.	32. 76	1. 062	0. 55	9. 43	4. 52	....	4. 36
468	20. White Imphee ..	......do	59. 86	1. 067	2. 31	10. 84	2. 87	11. 84	5. 66
476	24. New Variety, Stump.	Seed hard, sucker in dough.	58. 12	1. 060	1. 11	9. 81	2. 99	9. 57	5. 71
478	25. Early Amber....	Seed hard, sucker hard	60. 56	1. 076	0. 75	14. 13	2. 78	13. 94	10. 60
480	26. New Variety, H. S. Col.	Seed hard, sucker in dough.	60. 75	1. 054	1. 23	8. 51	3. 62	8. 19	3. 66
488	30. Red Sorgho	......do	61. 77	1. 067	1. 46	11. 60	2. 74	11. 52	7. 40
494	33. Neeazana	......do	58. 98	1. 071	2. 04	12. 40	2. 13	12. 01	8. 23
500	35. W. Liberian, Nesbit.	......do	57. 68	1. 065	0. 90	11. 23	2. 77	11. 29	7. 56
502	36. W. Liberian, Leaming.	......do	62. 90	1. 065	1. 13	11. 50	2. 63	11. 02	7. 74
504	37. New Variety, E. Link.	Seed hard, sucker in milk.	55. 74	1. 076	0. 89	13. 87	2. 83	13. 92	10. 15
560	20. White Imphee ..	......do	62. 43	1. 071	0. 90	12. 99	2. 90	12. 97	9. 19
562	21. White African..	......do	58. 35	1. 063	1. 15	10. 48	2. 89	10. 24	6. 44
612	24. New Variety, Stump.	Seed hard, sucker in dough.	57. 50	1. 066	1. 13	11. 47	3. 18	11. 09	7. 16
614	26. New Variety, H. S. Col.	......do	59. 07	1. 043	1. 17	6. 26	3. 09	5. 59	2. 00
619	29. Black Sorgho ...	Seed hard, sucker hard.	61. 33	1. 066	1. 57	12. 78	1. 17	12. 19	10. 04
621	30. Red Sorgho	Seed hard, sucker in dough.	58. 73	1. 065	1. 08	9. 93	4. 23	9. 77	4. 62
627	33. Neeazana	......do	58. 36	1. 077	1. 59	13. 77	2. 60	13. 72	9. 58
631	35. W. Liberian, Nesbit.	......do	54. 79	1. 066	1. 09	11. 42	2. 88	11. 28	7. 45
633	36. W. Liberian, Leaming.	......do	60. 98	1. 067	0. 90	12. 01	2. 63	11. 65	8. 48
635	37. New Variety, E.	Seed hard, sucker in milk.	58. 54	1. 080	0. 88	14. 80	2. 76	14. 45	11. 16
639	39. Chinese Imphee.	......do	58. 27	1. 077	1. 42	14. 16	7. 08	13. 60	5. 66
643	31. Link's Hybrid ..	Seed hard, sucker in dough.	59. 67	1. 075	0. 51	14. 01	2. 50	14. 59	11. 00
648	12. Dendemuka.....	......do	62. 82	1. 057	0. 92	9. 82	2. 58	10. 02	6. 32
664	18 A. Alogonde.....	......do	63. 45	1. 066	1. 79	11. 68	2. 02	....	7. 87
675	6. Ta Min Hung Liang.	Seed hard, sucker after bloom.	38. 37	1. 056	0. 76	7. 83	4. 08	....	2. 99
684	32. Standard Harrell	Seed hard, sucker in dough.	59. 77	1. 076	0. 57	14. 82	2. 95	....	11. 30
692	23. Neeazana	Seed hard, sucker hard.	53. 00	1. 076	1. 64	12. 38	3. 75	12. 12	6. 99
694	34. Gray Tops	Seed hard, sucker in dough.	62. 57	1. 064	1. 33	11. 09	2. 55	10. 84	7. 21
696	35. White Liberian, Nesbit.	Seed hard, sucker hard.	55. 47	1. 066	1. 22	11. 65	2. 66	10. 86	7. 77
752	12. Dindemuka	Seed hard, sucker in dough.	60. 93	1. 057	0. 83	9. 91	2. 64	9. 54	6. 44

development of plant—Continued.

SEED PRESERVED—Continued.

No. of analysis.	Variety.	Development.	Per cent. juice.	Specific gravity.	Per cent. glucose.	Per cent. sucrose	Per cent. solids.	Polarization.	Per cent. available sugar.
892	7. Undendebule	Seed hard, sucker seed in milk.	59.43	1.081	0.53	14.21	3.81	14.71	9.87
908	16 A. Ufatane	Seed hard, sucker seed in dough.	66.79	1.058	1.99	9.74	2.06	9.05	5.69
	Total		5341.78	5.580	129.07	916.18	268.02	806.28	516.00
	Average		58.063	1.0607	1.403	9.958	2.945	9.833	5.670

Average development: 8.75. Stage: Between seed head and sucker head in bloom.

425	7. Undendebule.....	Seed hard, sucker in milk.	59.66	1.076	0.60	13.97	3.14	14.19	10.23
427	8 A. Ukubane	Seed hard, sucker in dough.	62.70	1.064	1.10	11.43	2.86	11.68	7.47
437	15. Ubehlana	Seed in dough	60.32	1.072	0.57	13.10	2.99	13.13	9.54
441	16 B. Ufatane	......do..............	67.59	1.068	1.11	11.80	2.30	11.85	8.39
449	17 C. Unkunjane ...	......do..............	67.36	1.047	1.32	7.26	2.60	7.34	3.34
456	2. San Sui Hoong Liang.	Seed hard, sucker in milk.	40.60	1.056	0.45	9.33	3.13	8.09	5.75
469	20. White Imphee ..	...do..............	60.90	1.069	1.26	12.28	2.66	12.20	8.36
477	24. New Variety, Stump.	Seed in dough	57.64	1.069	1.04	12.19	3.33	11.90	7.82
479	25. Early Amber....	Seed hard, sucker hard	63.61	1.070	1.00	13.18	2.60	12.64	9.58
481	26. New Variety, H. S. Col.	Seed hard, sucker in dough.	55.78	1.056	1.11	9.55	3.07	9.49	5.37
489	30. Red Sorgho	......do..............	62.60	1.062	0.94	11.30	2.59	11.25	7.77
495	33. Neeazana	......do..............	52.51	1.076	1.41	14.06	2.62	13.96	10.03
501	35. White Liberian, Nesbit.	......do..............	57.18	1.074	0.70	13.71	2.79	13.46	10.22
503	36. White Liberian, Leaming.	Seed hard, sucker in bloom.	65.65	1.062	1.28	10.78	2.70	10.64	6.80
505	37. New Variety, E. Link.	Seed hard	63.72	1.061	1.74	....	....	14.41	......
561	20. White Imphee ..	Seed hard, sucker in dough.	61.57	1.070	0.92	12.88	2.63	12.48	9.33
563	21. White African ..	Seed hard	61.58	1.063	1.40	10.70	2.67	10.07	6.63
613	24. New Variety, Stump.	Seed hard, sucker in dough.	51.11	1.063	0.62	11.61	2.67	11.01	8.32
615	26. New Variety, A. S. Col.	.....do..............	56.31	1.064	1.15	11.43	2.67	10.85	7.61
620	29. Black Sorgho ...	Seed hard	60.00	1.060	0.68	12.17	0.96	11.87	10.53
622	30. Red Sorgho	......do..............	57.71	1.061	0.77	11.65	0.45	11.33	10.43
628	33. Neeazana	Seed hard, sucker in milk.	53.85	1.077	1.36	13.33	3.31	13.44	8.66
632	35. White Liberian, Nesbit.	Seed hard, sucker in dough.	52.00	1.063	1.16	10.95	—2.65?	10.42	......
634	36. White Liberian, Leaming.	......do..............	59.62	1.073	0.45	13.80	3.00	13.36	10.35
636	37. New Variety, E	Seed hard	58.27	1.070	1.41	14.23	0.97	12.54	11.85
640	39. Chinese Imphee	......do	58.91	1.073	0.56	13.83	2.49	13.40	10.78
644	31. Link's Hybrid ..	Seed hard, sucker in dough.	60.56	1.077	0.48	14.83	2.86	14.81	11.49
649	12. Dindemuka	......do	61.34	1.066	1.10	11.54	2.57	11.34	7.87
665	18 A. Alogonde.....	Seed hard	60.12	1.069	1.23	12.50	2.46	......	8.81
676	6. Ta Min Hung Liang.	......do	39.28	1.058	0.33	7.91	4.94	......	2.64
691	32. Standard Harrell	Seed hard, sucker in dough.	58.87	1.074	0.65	14.28	2.61	13.59	11.02
693	33. Neeazana	......do..............	52.80	1.074	1.83	13.25	2.44	12.45	8.98
695	34. Gray Tops	Seed hard	62.21	1.064	1.55	10.35	2.87	9.77	5.93
697	35. White Liberian, Nesbit.	Seed hard, sucker hard	53.12	1.076	1.05	13.27	3.33	12.68	8.89
753	12. Dindemuka	Seed hard, sucker in dough.	62.62	1.067	0.94	12.15	2.51	11.84	8.70

Effect of removing seed during

SEED REMOVED—Continued.

No. of analysis.	Variety.	Development.	Per cent juice.	Specific gravity.	Per cent. glucose.	Per cent. sucrose.	Per cent. solids.	Polarization.	Per cent. available sugar.
773	30. Red Sorgho	do	59.01	1.072	1.27	11.51	3.17	12.71	7.07
783	3 A. San Sui Pai Liang.	Seed hard, sucker in milk.	25.46	1.060	0.74	7.65	5.09		1.82
787	4. Er Chin Hung Liang.	Seed hard, sucker in dough.	38.08	1.056	0.82	8.85	3.45		4.58
789	6. Ta Min Hung Liang.	Seed hard, sucker in milk.	23.50	1.060	0.85	9.05	3.92		4.28
797	25. Early Amber	Seed hard. sucker hard.	59.42	1.064	1.15	11.07	3.12	11.08	6.80
805	33. Neeazana	do	55.45	1.069	1.54	12.24	3.44	11.80	7.26
829	12. Dindemuka	Seed hard, sucker in hard dough.	61.20	1.067	0.87	11.85	2.72	11.84	8.26
870	25. Early Amber	Seed hard. sucker hard.	51.68	1.075	0.85	13.77	2.54	13.41	10.38
900	12. Dindemuka	do	64.32	1.063	0.92	11.01	2.88	10.78	7.21
	Total		2489.01	2.910	53.09	498.78	135.36	424.92	310.33
	Average		56.069	1.06614	1.207	11.336	2.983	11.484	7.076

Average development: 11.57. Stage: Between sucker seed in milk and dough.

development of plant—Continued.

SEED PRESERVED—Continued.

No. of analysis.	Variety.	Development.	Per cent. juice.	Specific gravity.	Per cent. glucose.	Per cent. sucrose.	Per cent. solids.	Polarization.	Per cent. available sugar.
772	30. Red Sorgho	Seed hard, sucker in bloom.	63.64	1.066	2.50	13.61	1.64	10.98	9.47
784	3 A. San Sui Pai Liang.	Seed hard	29.58	1.066	0.64	10.55	4.29	......	5.62
788	4. Er Chin Hung Liang.	..... do.................	33.20	1.062	3.77	10.71	....	9.80	......
790	6. Ta Min Hung Liang.	......do................	39.45	1.059	0.52	9.04	3.97	8.38	4.55
798	25. Early Amber....	Seed hard, sucker hard	52.71	1.073	0.97	13.03	2.83	12.55	9.23
806	33. Neeazana	......do...............	53.96	1.070	1.79	12.29	2.23	11.92	8.27
830	12. Dindemuka	Seed hard, sucker in hard dough.	61.07	1.069	0 70	11.95	3.14	11.94	8.11
871	25. Early Amber.....	Seed hard, sucker hard	51.91	1.080	0.72	14.65	....	14.66	......
901	12. Dindemuka	......do................	60.28	1.071	0.77	12.82	3.10	12.70	8.95
	Total	....	2485.47	2.960	47.65	519.25	108.99	486.41	333.69
	Average	....	56.488	1.0673	1.083	12.075	2.725	11.864	8.342

Average development: 10.36. Stage: Between sucker head after bloom and sucker seed in milk.

In the first table there are given 92 and in the second 44 pairs of analyses.

It will be observed that in the first table there is a result indicating an earlier stage of development in those stalks upon which the seed was kept, while in the second table this difference is not marked.

To show the effect of this removal of seed the average results of the two tables are here given:

Effect of removing seed.

	Seed removed.	Seed on.	Per cent.	Seed removed.	Seed on.	Per cent.
Stage	10.42	8.75	84.0	11.57	10.36	89.5
Per cent. juice	55.775	58.063	104.1	56.569	56.488	99.9
Specific gravity	1.0717	1.0607	84.7	1.06614	1.0673	101.7
Per cent. glucose	.968	1.403	144.9	1.207	1.083	89.7
Per cent. sucrose	12.659	9.958	78.7	11.336	12.076	106.5
Per cent. solids	2.978	2.945	98.9	2.983	2.725	91.3
Polarization	12.734	9.883	77.6	11.484	11.864	103.3
Per cent. average sugar	8.650	5.670	65.5	7.076	8.342	117.9
Number of analyses	92	92	....	44	44	....

In the third and sixth columns is given the per cent. of the average results secured from the analyses of those canes with full seed-heads, of the average results obtained from the analyses of those canes from which the seed had been removed. It will be observed that in the average results of the first table there is an increase in juice of 4.1 per cent. and of glucose 44.9 per cent., and a decrease of every other element of the analyses: Of sucrose, 21.3 per cent.; of solids, 1.1 per cent.; of available sugar, 34.5 per cent.; and a decrease in specific gravity. It is also noticeable that while the average stage of development was about midway between the tenth and eleventh in those stalks from which the seed had been removed, it was below the ninth stage in the stalks of which the seed had been protected.

The averages from the second table give results indicating almost the opposite effect, for it will be noticed that although the tendency of the removal of the seed is to hasten the development and maturity of the plant, the average amount of juice and its specific gravity is practically the same; the amount of sucrose is greater, and that of glucose much less, the solids also being less, so that the per cent. of available sugar is increased 17.9 over that present in those juices from stalks not bearing seed.

The practical conclusions from these results are, that there is no incompatibility between the maximum crop of ripe seed possible, and the maximum content of sugar in the juice of the stalks; and that owing to the more rapid development of the cane from which the seed has been removed, the time necessary from planting to the maturity of the crop, which has been given in previous reports (Annual Reports Department of Agriculture, 1880, p. 130; 1881, p. 510), should be lengthened from seven to ten days for each of the varieties.

By comparing the average results above given, it will be seen that in

the one case the stalks with the seed on had not yet attained their maximum, while in the other case they had done so, and those with which they were compared, being without seed, had attained their maximum some time before and had retained it until the others had caught up with them in their sugar content.

It is also to be observed that those varieties upon the first table, where the difference was so much in favor of the stalks without seed, were largely the later maturing kinds, while in the second table the varieties are chiefly those maturing earlier.

An average of the number of days required from planting to maturity, as shown by this season's experiments, gives for the varieties of the first table 120 days, and for those of the second table 112 days, thus confirming the conclusions above given.

COMPARATIVE ANALYSES OF JUICES FROM THE STALKS AND LEAVES OF SORGHUM.

Owing to the trouble and expense involved in stripping the canes for the mill, the following analyses were made for the purpose of determining the effect of leaving the cane unstripped. In the eight experiments below recorded the stalks were topped as usual, and the blades from each lot weighed, passed through the mill, and the juice expressed The juices from stalks and leaves were then analyzed as usual.

In the Annual Report Department of Agriculture, 1879, p. 59, it will be seen that as the result of seven experiments, two with stripped and five with the unstripped stalks of sorghum, there was an increase of juice calculated to the raw stalks (*i. e.*, to stalks as cut in the field without topping or stripping). This would indicate that stripping was not necessary, and actually resulted in loss of sirup, if not in sugar. To more fully determine this the above-mentioned experiments were made, and the results are given in the following table:

Comparative analyses of juices from the stalks and leaves of sorghum at different periods of development.

Condition of plant.	No. of experiment.	Weight of stripped stalks.	Weight of leaves.	Per cent. of juice from stripped stalks.	Per cent. of juice from leaves.	Pounds of juice in stalks.	Pounds of juice in leaves.	Specific gravity of stalk juice.
		Lbs.	*Lbs.*					
Suckers	1	10.23	4.75	62.02	37.03	6.344	1.759	1.022
In bloom	2	7.81	1.73	64.00	25.00	4.998	.433	1.047
After bloom	3	6.85	1.54	67.89	26.64	4.650	.410	1.051
Seed in milk	4	7.58	1.35	64.67	27.77	4.900	.374	1.059
Seed in dough	5	7.25	1.07	62.61	26.40	4.539	.282	1.070
Sucker seed in dough	6	13.02	1.91	62.27	26.86	8.108	.513	1.068
Do	7	11.18	1.96	60.32	27.86	6.744	.546	1.072
Sucker seed, hard	8	16.34	2.80	54.09	34.83	8.838	.975	1.061
Do	9	12.70	2.13	62.35	34.61	7.918	.737	1.074
Sucker seed in milk	10	18.02	3.70	61.31	34.25	11.048	1.267	1.074
Sucker seed in dough	11	14.49	2.90	57.55	32.43	8.339	.941	1.075
Do	12	13.41	2.34	57.89	35.12	7.763	.822	1.068

Comparative analyses of juices from the stalks and leaves of sorghum, &c.—Continued.

Condition of plant.	Specific gravity of leaf juice.	Per cent. of sucrose in stalk juice.	Per cent. of glucose in stalk juice.	Per cent. of solids not sugar in stalk juice.	Per cent. of glucose in leaf juice.	Per cent. of sucrose in leaf juice.	Per cent. of solids not sugar in leaf juice.
Suckers	1.025	.66	2.04	2.53	.27	1.40	4.45
In bloom	1.040	4.48	5.67	2.25	2.29	2.93	5.27
After bloom	1.042	8.74	2.22	2.14	3.08	1.32	6.24
Seed in milk	1.047	10.29	3.21	1.84	2.84	1.66	7.82
Seed in dough	1.051	14.64	1.87	1.54	2.15	1.52	9.21
Sucker seed in dough	1.056	11.79	1.15	3.03	4.23	2.25	6.76
Do	1.049	13.31	.93	3.28	2.33	2.50	7.71
Sucker seed, hard	1.053	12.18	1.06	1.57	3.36	2.04	6.09
Do	1.044	13.83	.98	2.65	2.20	2.29	7.00
Sucker seed in milk	1.044	14.27	.69	2.71	2.58	1.22	6.29
Sucker seed in dough	1.048	13.00	1.75	3.79	2.53	3.50	4.10
Do	1.056	11.81	.94	3.07	2.25	1.89	13.25

Condition of plant.	Per cent. of total solids in stalk juice.	Per cent. of total solids in leaf juice.	Per cent. of available sugar in stalk juice.	Per cent. of available sugar in leaf juice.	Pounds of available sugar in stalk juice.	Per cent. of available sugar in leaf juice.	Per cent. of loss of available sugar with leaves.	Per cent. of gain of sirup with leaves.
Suckers	5.23	6.12	− 3.91	− 5.58	− .2481	−.0982	....	32.4
In bloom	12.40	10.49	− 3.44	− 5.91	− .1720	−.0256	....	7.3
After bloom	13.10	10.64	4.38	− 4.48	.2037	−.0185	9.1	7.1
Seed in milk	15.34	12.32	5.24	− 6.64	.2568	−.0249	9.7	6.2
Seed in dough	18.05	12.88	11.23	− 8.58	.5098	−.0242	4.8	4.4
Sucker seed in dough	15.97	13.24	7.61	− 4.78	.6170	−.0245	4.0	5.1
Do	17.51	12.54	9.10	− 7.88	.6137	−.0430	7.0	5.8
Sucker seed, hard	14.81	11.49	9.55	− 4.77	.8440	−.0465	5.5	8.6
Do	17.46	11.49	10.20	− 7.09	.8076	−.0523	6.5	6.1
Sucker seed in milk	17.67	10.09	10.87	− 4.03	1.2009	−.0625	5.2	6.6
Sucker seed in dough	18.54	10.13	7.46	− 5.07	.6221	−.0477	7.7	6.2
Do	15.82	17.39	7.80	−12.89	.6055	−.1060	17.5	11.6

The above results show that the effect of stripping the cane is to diminish the quantity of juice, but to improve its quality. It has been almost invariably stated that by leaving the blades upon the stalks a large amount of juice would be wasted.

Such is far from the case, but it is to be observed that in no case was there any available sugar in the juice from the leaves, owing not to the excess of glucose, but to the much larger percentage of solids not sugars in the leaf juice.

The general result, then, of putting the unstripped stalks through the mill is, as an average of the eight experiments, to occasion a loss of available sugar equal to 6.66 per cent. of the amount found in the juice from the stalks, and to cause a gain of 6.33 per cent. in the amount of sirup over that to be obtained from the juices of the stalks alone. This is due to the fact that the total sugars, with their solids not removed by defecation and skimming, go to increase the amount of syrup to be obtained from a juice.

COMPARATIVE VALUE OF DIFFERENT PARTS OF THE STALK OF SORGHUM FOR SUGAR.

In 1879 there were made a large number of analyses of the juices of four varieties of sorghum for the purpose of determining the relative value of the upper and lower halves of the cane for the production of sirup and sugar. The canes were in each case about equally divided by weight into upper and lower halves. The results obtained were as follows:

Average per cent. of water in tops, 79 specimens	72.45
Average per cent. of water in butts, 79 specimens	74.51
Average per cent. of juice from tops, 50 specimens	43.96
Average per cent. of juice from butts, 51 specimens	46.90
Average per cent. of solids in juice from tops, 77 specimens	16.18
Average per cent. of solids in juice from butts, 80 specimens	16.02
Average specific gravity of juice from tops, 84 specimens	1.071
Average specific gravity of juice from butts, 84 specimens	1.070

From the above results it appears that there exists no marked difference in the amount of juice present in the upper and lower halves of the canes, nor in the quality of the juice as indicated by either the specific gravity or the total amount of solid matter present. But it was found that during the early and immature state of the plant the relative amount of crystallizable sugar as compared with the total sugars present was much greater in the lower half of the canes. This condition was found to remain until the seed reached the milky state, at which time the juices in both the upper and lower halves appeared to be of equal value. It must not be understood that the maximum content of sugar in the plant was attained at this period, for from this time until the perfect ripening of the seed juices were found to uniformly increase in their content of crystallizable sugar and to decrease in that of uncrystallizable sugar.

Still later in the growth of the plant there was observed a slight deterioration in the quality of the juices from the lower halves of the stalks, and they were generally found to be somewhat inferior to the juices at this time present in the upper halves. It also was found that in the early examinations the specific gravity of the juices from the lower halves was almost invariably greater than that of the juices from the upper halves, and that equal specific gravities indicated an equality between the juices, not only in their content of sugar, but in the relative proportions of sucrose and glucose.

Owing to the fact that it is often advised to cut the crop two or three joints above the ground, under the belief that the butts were worthless for either sirup or sugar, the following experiments were made to ascertain whether such a course was advisable, in fact whether it did not involve a large waste of sugar. Since in the experiments above recorded the stalks were divided as nearly as possible into halves by weight, it might still be true that the butts of the cane were practically worth-

less; therefore, in the experiments of this year the stalks were cut as low down as possible and were divided into butts, middle, and tops, the analysis of each of which appears in the following table:

In each experiment 27 or 29 canes were taken. In the one case the seed was hard and in the other in dough. In the former each cane was divided in about equal parts by length into butt, middle, and top; and in the latter case the portion called butt was such portion as might naturally be left upon the field if the crop should be cut at the second or third joint. It will be seen that in this latter case the relation of butt to middle and top was in length as 1 to 8, and in weight of stripped stalk as 1 to 4.6.

Analyses of juices from butt, middle, and top of sorghum stalks.

No. of analysis.	Variety.	Condition of seed.	Number of canes.	Part taken.	Length in feet.	Stripped weight in pounds.	Juice expressed, pounds.	Per cent. of juice expressed.	Per cent. of glucose in juice.	Per cent. of sucrose in juice.	Per cent. of solids not sugar in juice.	Polarization of juice.	Per cent. of available sugar in juice.
252	Early amber ...	Hard ...	27	Butt	2. 0	8. 68	5. 25	60. 46	1. 15	10. 27	3. 01	10. 53	6. 11
253	...do	...do	27	Middle.......	2. 2	7. 94	4. 86	61. 21	1. 00	10. 77	3. 03	10. 54	6. 74
254	...do	...do	27	Top	2. 4	4. 22	2 48	58. 79	. 82	11. 33	3. 38	11. 16	7. 13
255	...do	...do	27	Entire cane.	6. 6	20. 84	12. 59	60. 41	1. 05	10. 92	3. 34	10. 61	6. 53
256	White Liberian.	Dough...	29	Butt	. 8	3. 51	1. 91	54. 43	. 85	12. 65	4. 07	13. 09	7. 73
257	...do	...do	29	Middle.......	2. 3	8. 73	5. 13	58. 80	. 94	11. 64	3. 84	12. 14	6. 86
258	...do	...do	29	Top	3. 7	7. 53	4. 46	59. 23	. 73	11. 82	4. 47	12. 09	6. 62
259	...do	...do	29	Entire cane.	6. 8	19. 77	11. 50	58. 19	. 88	12. 04	3. 28	12. 25	7. 88

From the above table it will be seen that there was practically very little difference in the juice obtained from butts, middles, or tops, either in the amount expressed by the mill or in its composition. It will be also observed that in the maturer cane the juice from the butts was in its per cent. of sucrose and available sugar slightly less than that from the middle, while that from the tops was best of all. In the cane, however, the seed of which was in the dough exactly the reverse was true, the juice from the butts being the best of all. It is therefore safe to say that the crop should be cut as near the roots as possible, whether intended for sugar or sirup, since, as will be seen, the butts, though only about 9 inches long, equaled about one-fifth the weight of the cane.

EFFECTS OF FROST UPON SORGHUM.

In 1881 the first frost occurred October 6, and the successive frosts for the season were October 11, November 14, 16, 17, 28. The mean temperature for October was 77° and for November 62.9°, with a maximum temperature in October of 88.6° and in November of 76.1°. The effect of these frosts and of this high temperature is shown in Annual Report 1881–'82, p. 459. It was shown, however, that the effects produced were determined largely, if not entirely, by the condition oft he sorghums at the time of the frost.

Upon p. 461, Annual Report 1881–'82, the average results produced by frost upon six of the late-maturing varieties which had not yet attained complete ripeness is contrasted with the average results produced on nine of the early-maturing varieties which had attained complete maturity long before the frost. These results were as follows:

	Average of the late-maturing varieties.		Average of the early-maturing varieties.	
	Per cent.		*Per cent.*	
Sucrose	Loss,	44.1	Gain,	2.9
Glucose	Gain,	26.3	Gain,	22.5
Solids	Loss,	15.9	Gain,	51.4
Juice	Gain,	6.0	Gain,	2.3
Specific gravity	Loss,	30.9	Gain,	5.1
Available sugar	Loss,	69.8	Loss,	12.1

As will be seen from the above, there is practically little effect shown by the frost upon the several varieties which were quite mature, while the effect upon the other group was most disastrous, reducing the sucrose 44.1 per cent. and the available sugar 69.8 per cent.

In 1882, however, as has been already pointed out, the meteorological conditions of this locality differed so widely from those of the preceding year that it effected practically a change of climate. The first frost occurred November 3, nearly a month later than upon the two years preceding, and was followed by successive frosts upon November 5, 6, 15, 16, 19, 21, 22, 23, 24, 26, December 2, 4. The mean temperature after the first frost, and until December 8, when the last examination of the sorghums was made, was 39.8°, with maximum temperatures November 12 of 74.1° and November 13 of 70.8°.

For greater ease of comparison the above data for 1881 and 1882 are placed side by side in the following table:

	1881.	1882.
First frost	Oct. 6	Nov. 3
Other frosts	Oct. 11	Nov. 5
	Nov. 14	Nov. 6
	Nov. 16	Nov. 15
	Nov. 17	Nov. 16
	Nov. 28	Nov. 19
		Nov. 21
		Nov. 22
		Nov. 23
		Nov. 24
		Nov. 26
		Dec. 2
		Dec. 4
Mean temperature, October	77.0°	61.0°
Maximum temperature, October	88.6°	81.3°
Mean temperature, November	62.9°	42.9°
Maximum temperature, November	76.1°	74.1°

To show the effects of the frosts this year, there is given in the following table the results of the analyses of the nine varieties which were last examined on December 8, and, for the purpose of comparison, the last analyses made of these same varieties just before the first frost of November 3.

It is important to mention that each of these nine varieties had ripened their seed some time before the first frost, and that among the nine there were three of the new African varieties, viz, Nos. 7, 12, and 16*a*

EFFECTS OF FROST, 1882.

Last analyses made after thirteen frosts, December 8.

No. of analysis.	Row number.	Date.	Per cent. of juice.	Specific gravity.	Per cent. glucose.	Per cent. sucrose.	Per cent. solids.	Available sugar.	Polarization.
1122	33	Dec. 8	42. 20	1. 0826	3. 38	12. 88	2. 53	6. 97	11. 48
1123	35	..do....	35. 92	1. 0854	3. 43	11. 78	2. 74	5. 61	10. 94
1124	36	..do....	34. 90	1. 0834	3. 91	11. 92	2. 90	5. 11	9. 83
1125	37	..do....	43. 40	1. 0905	2. 53	14. 98	3. 00	9. 45	13. 81
1126	38	..do....	39. 25	1. 0953	3. 34	15. 17	2. 61	9. 22	13. 72
1127	39	..do...	37. 13	1. 0932	2. 82	14. 97	3. 09	9. 06	......
1128	7	..do....	35. 01	1. 1046	2. 33	17. 19	3. 67	11. 19	......
1129	12	..do....	42. 54	1. 0919	1. 96	15. 34	3. 08	10. 30	14. 40
1130	16*a*	..do....	42. 16	1. 0887	1. 95	14. 96	3. 16	9. 85	13. 94
Average	......	....	39. 17	1. 0906	2. 85	14. 35	2. 98	8. 52	......

Last analyses made before first frost, November 3.

No. of analysis.	Row number.	Date.	Per cent. of juice.	Specific gravity.	Per cent. glucose.	Per cent. sucrose.	Per cent. solids.	Available sugar.	Polarization.
805	33	Nov. 2	55. 45	1. 0689	1. 54	12. 24	3. 44	7. 26	11. 80
*806			53. 96	1. 0703	1. 79	12. 29	2. 23	8. 27	11. 92
808	35	Nov. 2	57. 43	1. 0731	1. 08	13. 07	1. 93	10. 06	12. 80
698	36	Oct. 25	53. 65	1. 0700	1. 46	12. 37	2. 53	8. 38	12. 11
700	37	Oct. 25	50. 83	1. 0834	. 93	15. 05	3. 20	10. 92	15. 03
*701			60. 10	1. 0777	1. 90	11. 67	2. 39	7. 38	11. 40
*747	38	Oct. 30	58. 16	1. 0681	1. 40	11. 61	2. 56	7. 65	11. 11
639	39	Oct. 20	58. 27	1. 0768	1. 42	14. 16	......	....	13. 60
*640			58. 91	1. 0732	. 56	13. 83	2. 49	10. 78	13. 40
748	7	Oct. 30	60. 52	1. 0741	. 55	13. 65	2. 86	10. 24	13. 51
*749			60. 30	1. 0693	. 44	12. 06	3. 24	8. 38	11. 63
752	12	Oct. 30	60. 93	1. 0571	. 83	9. 91	2. 64	6. 44	9. 54
*753			62. 62	1. 0669	. 94	12. 15	2. 51	8. 70	11. 84
764	16*a*	Oct. 31	57. 88	1. 0692	1. 58	11. 90	......	....	11. 74
*765			63. 86	1. 0632	2. 01	10. 60	2. 75	5. 84	10. 15
Average	......	....	58. 19	1. 0707	1. 23	12. 44	2. 68	8. 62	12. 11

The results above given are very interesting and a little surprising. It will be seen that the average shows, as the effects of these repeated frosts and long-continued cold weather of nearly fifty days from the time when the first examinations were made, October 20, to the last, December 8, the following:

	Per cent.
Loss of juice	32. 69
Gain in spacific gravity	28 15
Gain in glucose	131. 71
Gain in sucrose	15. 35
Gain in solids	11. 19
Loss in available sugar	1. 16

The average results obtained by the polariscope before the frosts was 97.35 per cent. of those obtained by analysis, while the results after the frosts were only 90.84 per cent. This result is in all probability due to the presence of inverted sugar in the juice, as is indicated by the increase of glucose, which increase amounts upon an average to 1.62 per cent. of the juice.

The increased percentage of sugar in these juices obtained after the frosts must not be regarded as an actual increase of sugar in the plant, for on the other hand there has been a very considerable loss of sugar, as is indicated not only by the increase in the glucose, which now consists largely of inverted sugar, as the polariscope determinations show, but there has been a very large loss of juice, showing a loss of water. Indeed, there seems in this case to have been a gradual drying up of the water of the plant; and the increased per cent. of sugar shows only that the inversion of the sugar and the fermentation and disappearance of the glucose did not proceed quite as rapidly in proportion.

The following table will show the relative composition of the juices before and after these frosts, and the results calculated to the stripped cane:

	Before frosts.	After frosts.
	Per cent.	*Per cent.*
Juice from stalks	58.19	39.17
Sucrose in juice	12.44	14.35
Glucose in juice	1.23	2.85
Solids in juice	2.68	2.98
Total solids in juice	16.35	20.18
Available sugar in juice	8.53	8.52
Water in juice	83.65	79.82
Sucrose expressed from stalks	7.24	5.62
Glucose expressed from stalks	.71	1.11
Solids expressed from stalks	1.56	1.17
Total solids expressed from stalks	9.51	7.90
Available sugar expressed from stalks	4.97	3.34
Water expressed from stalks	48.68	31.27

From the above it will be seen that the effects of these frosts upon the several constituents of the juices calculated to the stripped stalks showed—

Loss of sucrose	22.38 per cent., or	1.62 per cent. of stalks.
Gain of glucose	56.34 per cent., or	.40 per cent. of stalks.
Loss of solids	25.00 per cent., or	.39 per cent. of stalks.
Loss of total solids	16.93 per cent., or	1.61 per cent. of stalks.
Loss of available sugar	32.80 per cent., or	1.63 per cent. of stalks.
Loss of water	35.77 per cent., or	17.41 per cent. of stalks.

These results above detailed must not be regarded as in conflict with the conclusions published in the annual report 1881–'82, p. 502, where the increase in sugar during the later stages in the development of the sorghum was shown not to be due to a loss of water by drying up of the plant, as has been supposed by many, but was an actual increase in sugar.

For comparison with the results just given, the results obtained in 1881 are in part repeated here.

Two stages of development are selected for comparison—the eleventh, when the seed was just hard and when the amount of juice was at its maximum, and the seventeenth, which represents several weeks after the seed had ripened.

The average analyses of the juices of 35 varieties of sorghum gave the following results:

	Eleventh stage.	Seventeenth stage.
Number of analyses	166	197
Juice from stalks per cent	65.04	60.17
Sucrose in juice do	10.66	13.72
Glucose in juice do	2.35	1.56
Solids in juice do	2.72	4.07
Total solids in juice do	15.73	19.35
Available sugar in juice do	5.59	8.09
Water in juice do	84.27	80.65
Sucrose expressed from stalks do	6.93	8.26
Glucose expressed from stalks do	1.53	.94
Solids expressed from stalks do	1.77	2.45
Total solids expressed from stalks do	10.23	11.65
Available sugar expressed from stalks do	3.63	4.87
Water expressed from stalks do	54.81	48.52

Calculating these results to the stripped stalks, we find between the eleventh and seventeenth stages the following:

Gain in sucrose	19.19 per cent., or 1.33 per cent. of stalks.
Loss in glucose	38.56 per cent., or .59 per cent. of stalks.
Gain in solids	38.42 per cent., or .68 per cent. of stalks.
Gain in total solids	13.88 per cent., or 1.42 per cent. of stalks.
Gain in available sugar	34.16 per cent., or 1.24 per cent. of stalks.
Loss in water	11.48 per cent., or 6.29 per cent. of stalks.

It appears, therefore, conclusively established that long after the seed has thoroughly ripened, and indeed as all of our results, until the plant is killed by the frost, there is a steady increase in the amount of sugar in the juice, which is actual and not due to loss of water; and that this increase extends also to the available sugar, which, as will be seen above, increased from the eleventh to the seventeenth stages 34.16 per cent., while the sugar increased only 19.19 per cent. This result has been established by the continued experiments of the past four years.

COMPARISON OF ANALYSIS WITH POLARIZATION OF SORGHUM JUICES.

In the examination of sorghum juices this year there was taken, for the purpose of controlling analytical results, the polarization of the juices. In all, 855 juices from the several varieties of sorghum under cultivation, and in every condition of development, were thus examined, and the average results are as follow:

	Per cent.
Sucrose by analysis	10.938
Sucrose by polarization	10.966

Or as 100 : 100.265.

The first 548 analyses made gave even closer results, viz:

	Per cent.
Sucrose by analysis	10.585
Sucrose by polarization	10.577

Or as 100.074 : 100.

The above results prove beyond all question that the analytical method employed in these investigations is as accurate as could be desired, and that the results secured by this method are entitled to entire confidence in their substantial accuracy.

In 1881 the average results of 697 analyses gave:

	Per cent.
Sucrose by analysis	11.095
Sucrose by polarization	10.676

DUPLICATE ANALYSES OF SORGHUM JUICES.

For the purpose of controlling the results of analyses, there have been made, during the season of 1882, twenty-four analyses of sorghum juices in duplicate.

In no case did those who were engaged in the analyses have any reason to suspect that they were at work upon duplicates, the samples having been prepared and sent into the laboratory under their several numbers as being individual specimens of juice. Thus, Nos. 105 and 113 were duplicate juice, and so on, Nos. 107 and 115 being also duplicates.

It will be observed that the agreement is quite as close as could be expected in work of such a character, and that the average results given at the close of this table show that in the anylitical work there is nothing to cause doubt as to the substantial accuracy of the work recorded.

Duplicate analyses of sorghum juices.

Number of analysis.	Specific gravity.	Per cent. of glucose.	Per cent. of sucrose.	Per cent. of solids.	Per cent. of polarization.	Number of analysis.	Specific gravity.	Per cent. of glucose.	Per cent. of sucrose.	Per cent. of solids.	Per cent. of polarization.
105	1.042	5.40	2.72	1.69	3.06	113	1.042	5.65	3.13	.87	3.20
107	1.034	3.25	3.73	1.30	4.24	115	1.034	3.26	3.83	1.25	3.72
109	1.038	3.27	4.69	1.29	5.28	114	1.038	3.27	4.86	1.21	5.24
111	1.053	3.38	8.30	1.14	8.01	116	1.053	3.41	7.82	1.57	7.90
133	1.072	2.10	12.96	3.07	13.44	136	1.073	1.93	12.81	3.27	13.53
158	1.068	1.15	11.79	3.26	12.06	160	1.069	1.16	11.59	3.03	12.14
150	1.063	2.79	10.06	2.55	10.21	157	1.063	2.92	10.23	2.21	10.28
161	1.072	.93	13.31	3.28	13.60	163	1.073	.93	13.31	3.54	13.60
168	1.057	3.23	8.37	2.35	8.68	180	1.057	3.18	8.26	2.29	8.69
169	1.056	2.02	8.92	2.63	9.36	181	1.056	2.05	8.78	2.45	9.34
173	1.068	1.57	12.03	2.64	12.44	179	1.068	1.53	11.96	2.70	12.55
182	1.057	1.48	8.48	3.41	8.54	183	1.057	1.49	8.45	3.09	8.52
189	1.058	2.13	10.41	2.50	......	202	1.059	2.18	9.99	......	10.48
191	1.057	3.29	8.50	2.24	......	203	1.056	3.29	7.91	2.75	8.47
192	1.069	2.44	11.65	2.79	......	204	1.069	2.41	11.60	2.88	12.05
194	1.056	2.42	8.86	2.24	9.01	205	1.056	2.46	8.70	2.55	......
206	1.038	.67	5.72	2.92	......	207	1.038	.67	5.93	2.88	......
224	1.071	1.05	13.15	3.27	13.44	226	1.071	1.12	13.37	3.26	13.48
214	1.069	1.89	12.48	2.73	12.91	227	1.069	1.87	12.73	2.58	12.02
216	1.073	1.82	12.94	3.20	13.68	228	1.073	1.54	13.50	2.76	13.76
212	1.071	.84	13.39	2.98	13.53	229	1.071	.89	13.73	2.98	13.48
220	1.071	1.19	12.54	3.40	13.23	230	1.071	.93	11.11	5.15	13.48
221	1.061	4.11	8.22	2.81	8.70	231	1.061	4.04	8.49	2.54	8.64
219	1.061	1.64	10.31	3.24	10.93	232	1.062	1.68	10.95	2.56	11.02
	1.435	54.06	233.53	60.43	195.34		1.439	53.86	233.04	60.37	194.59
Average	1.0598	2.252	9.729	2.627	10.281	Average	1.0600	2.244	9.710	2.625	10.242

TESTS OF THE ACCURACY OF THE CHEMICAL WORK.

As in past years, there has been taken every reasonable precaution to secure accurate results in the analytical work of this sorghum investigation.

The several methods of checks and control have been such that, although errors may exist in individual analyses, it is impossible that the general results recorded should be other than very close approximation to the truth.

It will be seen, in another place, that the average results this year of the analyses of 855 sorghum juices gave 10.938 per cent. of sucrose by precipitation, while the same juices gave an average of 10.966 per cent. by the polariscope; or as 100 : 100.255, practically identical results.

It will be seen that during the season there were made in all analyses of 24 juices in duplicate, and, as has been said, none of those engaged upon these analyses had any knowledge of the fact that duplicate juices were present in the 20 or more samples under analysis.

The average results of these 24 analyses, in duplicate, are as follows:

Specific gravity	1.0598	1.0600
Per cent. sucrose	9.729	9.710
Per cent. glucose	2.252	2.244
Per cent. solids, not sugar	2.627	2.625
Per cent. polarization	10.281	10.244

These results also are practically identical.

There was also made a series of analyses of solutions of known quantities of commercial cane sugar and of anhydrous glucose, both separate and mixed.

The results of these analyses are given in the following table. They show clearly the substantial accuracy of the analytical methods employed in the work which has been recorded; but it is interesting to observe that, while the specific gravity, polarization, and analytical results for each constituent agree very closely in the duplicate analyses made, there is found as the aggregate of four of the analyses, where sucrose alone was taken, as follows:

	Grams.
Sucrose taken	17.63
Sucrose found	17.58

Also, in those four cases where there was taken anhydrous glucose, the following results were obtained in the aggregate:

	Grams.
Glucose taken	17.12
Glucose found	17.11

But in these cases, eight in all in which both sucrose and glucose were present in the solutions analyzed, the aggregate results are as follows:

Sucrose taken, 20.505 grams.; found, 22.68 grams.

Glucose taken, 19.810 grams.; found, 20.39 grams.

It will be seen that while the amount of glucose taken is approxi-

mately equal to that found, as in the case of analyzing the solution of glucose alone, still the amount of sucrose found is 10.4 per cent. greater than the amount taken. This result is in all probability due to the fact that there existed as impurity in the anhydrous glucose taken a certain quantity of some product intermediate between starch and glucose, which, while not reducing the Fehling solution in the estimation of the glucose, was converted into glucose by treatment with acid in the estimation of the sucrose.

Tests of accuracy.

Number of analysis.	Sucrose taken.	Glucose taken.	Sucrose calculated.	Glucose calculated.	Sucrose found.	Glucose found.	Total solids found.	Polarization.	Specific gravity.
87	5.00	.00	4.9050	.000	5.05	.00	4.94	4.89	1.015
88	2.50	2.50	2.4525	2.405	2.43	2.49	5.25	4.25	1.015
89	.00	5.00	.0000	4.820	.07	4.78	5.02	3.49	1.0143
199	5.00	.00	4.9050	.000	4.72	.00	5.38	4.92	1.016
200	2.50	2.50	2.4525	2.405	2.26	2.38	4.96	4.04	1.016
201	.00	5.00	.0000	4.820	.11	4.84	4.96	3.51	1.0154
1131	2.00	2.00	1.9550	1.875	2.31	1.91	3.88	3.13	1.013
1138	2.00	2.00	1.9550	1.875	2.12	1.96	3.82	3.04	1.013
1134	4.00	2.00	3.9100	1.875	3.95	1.90	5.82	4.92	1.020
1136	4.00	2.00	3.9100	1.875	3.68	1.99	5.75	5.00	1.020
1132	2.00	4.00	1.9550	3.750	2.14	3.77	5.63	4.65	1.020
1139	2.00	4.00	1.9550	3.750	2.48	3.79	5.65	4.51	1.020
1135	.00	4.00	.0000	3.750	.49	3.78	3.83	2.54	1.013
1137	.00	4.00	.0000	3.750	.64	3.71	3.81	2.58	1.013
1133	4.00	.00	3.9100	.000	3.82	.10	3.86	3.90	1.013
1140	4.00	.00	3.9100	.000	3.99	.10	3.93	3.92	1.013
	39.00	39.00	38.1750	36.930	40.26	37.50	76.49	63.29	......

ANALYSES OF FRESH AND RY JUICES.

In the following table is given the analyses of thirteen juices in their condition as freshly expressed, and after they had been rapidly dried in a warm chamber.

It is intended to make a more thorough examination of these dried juices to determine the character of the several constituents present besides the sugars, viz, the organic substances which are to be removed, if at all, by defecation, and the mineral constituents of the ash.

Excluding the analyses of the juices from suckers and leaves Nos. 364 and 365, as being hardly comparable with the others, the average analysis of the fresh juices is as follows:

Per cent. of juice expressed	56.62
Specific gravity	1.0702
Per cent. glucose in juice	1.17
Per cent. sucrose in juice	12.36
Per cent. solids not sugar in juice	3.08
Per cent. polarization	12.16
Per cent. water in juice	85.52
Per cent. dry matter in juice	14.47

It will be observed that there was lost by drying 85.52 per cent., and

the solids remaining were 14.47 per cent.; but, as will be seen by the analyses of the fresh juices, there was an average of 16.61 per cent. of total solids; this shows that in the operation of drying there was a loss of 2.14 per cent., equal to 12.88 per cent. of the total solids.

The average proximate analyses of the dried juices gave:

	Per cent.
Ether extract	0.82
Alcohol extract	70.15
Water extract	8.23
Insoluble	20.80
	100.00

	Per cent.
Albuminoids (nitrogen × 6.25)	6.37
Ash	5.87
Sucrose	39.96
Glucose	12.32
Water	3.06
Undetermined	32.42
	100.00

The ether extract contains free organic acids, chlorophyll, fixed oils, fats and waxes, volatile oils, but no mineral matter.

The alcohol extract contains mineral matter, nitrates, organic acids and their salts, glucosides, coloring matter, sugars, albuminoids and non-albuminoids, nitrogenous matter, amides, &c.

The water extract contains soluble albuminoids, gum, pectin matter, dextrinoid bodies, and coloring matter.

The insoluble matter consists of crude fibre and mineral matter, silica, &c.

Now, it will be seen that there was present in the total solids of the fresh juices 81.46 per cent. of the two sugars, but in the total solids of the dried juices there was only 52.28 per cent. of the two sugars. Also, there was in total sugars of the fresh juices 91.35 per cent. of sucrose and 8.65 per cent. of glucose; but in the total sugars of the dried juices there was only 76.44 per cent. of sucrose and 23.56 per cent. of glucose.

The above results are important as showing how liable the juice is to undergo fermentation and loss of sugar, during evaporation even, unless by means of defecation certain impurities be removed; and although many farmers still persist in the manufacture of sirup, "without chemicals" as they say, by simply boiling down the freshly expressed juice, removing only such impurities as may be brought to the surface as scum during the evaporation, it is altogether likely that they have a loss of sugar greater than would occur in the sediment and scum of a good defecation, besides producing a sirup which is likely to have poor keeping qualities, owing to its tendency to ferment upon the approach of warm weather.

The analyses of the suckers No. 364, and of the leaves from the suckers No. 365, are interesting and of practical value.

These suckers were those that had sprung up from the roots of those stalks which had been previously cut up for analyses, and it will be observed how low is the contents of sugar and how great the percentage of ash in their juices. The large percentage of nitrogen is also noticeable, as also the ether extract of the leaves, owing to an excess of chlorophyll in the leaf juice. The worthlessness, therefore, of immature suckers for the purpose of sugar production is obvious, and also the importance of stripping the cane in order to secure the best results in sugar is manifest. In another portion of this report this matter is considered at greater length.

Analyses of fresh and dried juices.

FRESH JUICES.

Date.	Variety.	Number of analysis of fresh juice.	Per cent. of juice.	Specific gravity.	Per cent. of glucose.	Per cent. of sucrose.	Per cent. of solids not sugar.
Sept. 14	New variety (H. S. Coll)	158	62.27	1.068	1.15	11.79	3.26
14	White Liberian (Nesbit)	161	60.32	1.072	.93	13.31	3.28
21	New variety (H. S. Coll)	233	54.09	1.061	1.06	12.18	1.57
21	White Liberian (Nesbit)	235	62.35	1.074	.98	13.83	2.65
23	White Liberian (Nesbit)	259	56.82	1.068	.88	12.04	3.28
23	New variety (H. S. Coll)	255	60.15	1.063	1.05	10.79	3.34
Oct. 3	Suckers from rows 2, 3, 4, 5	364	62.02	1.022	2.04	.66	2.53
3	Leaves from rows 2, 3, 4, 5	365	37.03	1.025	1.40	.27	4.45
10	Neeazana	482	57.55	1.075	1.75	13.00	3.79
11	Link's hybrid	498	61.31	1.074	.69	14.27	2.71
12	White Liberian (Nesbit)	514	57.89	1.068	.94	11.81	3.07
13	White Liberian (Leaming)	530	58.86	1.070	.72	12.14	3.68
16	Ta-Min-Hung-Liang	559	48.58	1.054	.58	7.94	3.69
Dec. 8	New variety (R. Haswell)	1126	39.25	1.095	3.34	15.17	2.61
	Average	....	56.62	1.0702	1.17	12.36	3.08

Date.	Variety.	Per cent. of polarization.	Per cent. of bagasse.	Weight of juice.	Weight of dry juice.	Per cent. of water in juice.	Per cent. of dry juice.
Sept. 14	New variety (H. S. Coll)	12.06	37.73	3106	468	84.93	15.07
14	White Liberian (Nesbit)	13.60	39.68	2532	410	83.81	16.19
21	New variety (H. S. Coll)	11.16	45.91	2825	437	84.53	15.47
21	White Liberian (Nesbit)	13.65	37.65	2860	505	82.34	17.66
23	White Liberian (Nesbit)	12.35	43.18	3494	417	88.06	11.94
23	New variety (H. S. Coll)	10.61	39.85	3964	407	89.73	10.27
Oct. 3	Suckers from rows 2, 3, 4, 5	1.31	37.98	2541	136	94.65	5.35
3	Leaves from rows 2, 3, 4, 5	—.98	62.97	571	45	92.12	7.88
10	Neeazana	13.27	42.45	3203	439	86.29	13.71
11	Link's hybrid	14.21	38.69	4668	525	88.75	11.25
12	White Liberian (Nesbit)	11.38	42.11	2878	420	85.41	14.59
13	White Liberian (Leaming)	12.49	41.14	2765	339	87.74	12.26
16	Ta-Min-Hung-Liang	7.45	51.42	....	479	....	....
Dec. 8	New variety (R. Haswell)	13.72	60.75	1449	302	79.18	20.82
	Average	12.16	43.38	....	....	85.52	14.47

DRIED JUICES.

Date.		Variety.	Number of analysis of dry juice.	Remarks.	Per cent. ether extract.	Per cent. alcohol extract.	Per cent. water extract.	Per cent. insoluble residue.
Sept.	14	New variety (H. S. Coll)	1302		.40	72.52	12.42	14.66
	14	White Liberian (Nesbit)	1303		.42	60.35	5.67	33.56
	21	New variety (H. S. Coll)	1306		.87	80.53	3.29	15.31
	21	White Liberian (Nesbit)	1307		.40	81.55	3.07	14.98
	23	White Liberian (Nesbit)	1310		.69	72.64	7.01	19.66
	23	New variety (H. S. Coll)	1311	Fermented	.79	67.06	10.46	21.69
Oct.	3	Suckers from rows 2, 3, 4, 5	1314		.70	62.13	12.85	24.32
	3	Leaves from rows 2, 3, 4, 5	1315		7.19	47.85	12.02	32.94
	10	Neeazana	1317		.67	73.73	13.75	11.85
	11	Link's hybrid	1319		1.54	62.12	3.57	32.77
	12	White Liberian (Nesbit)	1321		2.22	56.75	20.63	20.40
	13	White Liberian (Leaming)	1323		.52	81.15	4.08	14.25
	16	Ta-Min-Hung-Liang	1334	Fermented	Lost			
Dec.	8	New variety (R. Haswell)	1337		.47	63.24	6.60	29.69
		Average			.817	70.15	8.23	20.80

Date.		Variety.	Per cent. nitrogen multiplied by 6.25.	Per cent. glucose.	Per cent. sucrose.	Per cent. ash in alcohol extract.	Per cent. total ash.	Per cent. moisture.
Sept.	14	New variety (H. S. Coll)	5.750	9.866	43.193	3.68	5.80	1.90
	14	White Liberian (Nesbit)	5.625	8.533	52.186	3.31	5.45	2.40
	21	New variety (H. S. Coll)	5.625	13.666	48.703	4.38	5.65	3.65
	21	White Liberian (Nesbit)	5.625	8.533	56.873	2.62	4.50	6.30
	23	White Liberian (Nesbit)	5.750	11.000	39.330	3.96	7.15	2.10
	23	New variety (H. S. Coll)	5.938	9.000	32.110	4.60	7.85	2.40
Oct.	3	Suckers from rows 2, 3, 4, 5	15.938			12.34	7.30	6.25
	3	Leaves from rows 2, 3, 4, 5	21.000			10.08	8.20	3.80
	10	Neeazana	3.688	18.933	30.780	5.14	4.65	2.60
	11	Link's hybrid	9.250	22.133	16.973	4.61	5.60	2.75
	12	White Liberian (Nesbit)	7.188	14.066	22.736	3.19	6.35	2.65
	13	White Liberian (Leaming)	8.250	8.333	46.550	4.51	5.85	2.35
	16	Ta-Min-Hung-Liang						
Dec.	8	New variety (R. Haswell)	7.375	11.400	50.096	4.44	5.70	4.60
		Average	6.369	12.315	39.956	4.04	5.87	3.06

ANALYSES OF SORGHUM LEAVES.

In the following table is given the analyses of the leaves of four varieties of sorghum, and of the juice expressed from the stalks from which the leaves were taken. It will be seen that there is in the dried leaves an average of 5.41 per cent of total sugars, while the average amount of total sugars in the juices from the stalks is 14.44 per cent., and, as has been shown in another portion of this report, there is an increase of about 6 per cent. in the amount of sirup, and a decrease of about 6 per cent. in the amount of available sugar when the stalks are passed unstripped through the mill, as compared with the sirup and sugar produced by pressing the stripped stalks.

But it will be seen that these leaves have a composition which shows them to be of very great nutritive value, and for purpose of fodder they are well worth preserving whenever one strips his cane for the mill. Indeed their value is such that should they be carefully preserved they would easily repay the cost of stripping.

For purpose of comparison, the following average analyses representing the composition of five samples of hay are given, A, and the average composition of a large number of American grasses, B, given in the Annual Report of this Department for 1879, pp. 123 and 112. The average of the four varieties of sorghum leaves is given in C.

	Ash.	Fat.	Nitrogen free extract.	Albumen.	Fibre.	Nutritive ratio.
A	5.36	4.95	52.93	8.78	27.14	1 : 6.6
B	7.90	2.90	53.90	8.20	27.10	1 : 6.9
C	10.18	7.06	55.57	13.61	16.54	1 : 4.1

It appears, then, that the leaves of the sorghum have a higher nutritative ratio than our grasses or hay, and as will be seen from the analyses there is present in them, when dried with care, a large percentage of sugars and albuminoids, two of the most important constituents of animal food.

Analyses of leaves of sorghum.

Date.	Variety.	Number of analysis.	Per cent. of juice.	Specific gravity.	Per cent. of glucose.	Per cent. of sucrose.	Per cent. of solids, not sugar.
Sept. 27	African canes						
Oct. 18	White Liberian (Leaming)	605	49.95	1.068	1.14	12.11	2.77
18	Early Amber	606	63.61	1.070	1.00	18.18	2.60
18	Link's hybrid	607	56.47	1.080	.46	15.41	3.26
	Average		56.68	1.0727	.87	13.57	2.88

Date.	Variety.	Per cent. polarization.	Weight of fresh leaves.	Weight of dry leaves.	Per cent. of water in leaves.	Per cent. of dry substance in leaves.
Sept. 27	African canes		564	155	72.52	27.48
Oct. 18	White Liberian (Leaming)	11.81	322	92	71.43	28.57
18	Early Amber	12.64	482	112	74.07	25.93
18	Link's hybrid	15.45	396	117	70.45	29.55
	Average	13.30			72.12	27.88

Date.	Variety.	Number of analysis of leaves.*	Per cent. ether extract.	Per cent. alcohol extract.	Per cent. water extract.	Per cent. insoluble residue.	Per cent. nitrogen multiplied by 6.25.	Per cent. crude fibre.
Sept. 27	African canes	1335	6.29	18.67	1.82	73.22	14.500	17.475
Oct. 18	White Liberian (Leaming)	1325	7.41	21.48	2.86	68.25	15.063	15.450
18	Early Amber	1327	7.08	21.63	2.51	68.78	13.500	16.475
18	Link's hybrid	1329	7.48	22.26	2.58	67.68	11.375	16.750
	Average		7.06	21.01	2.44	69.48	13.609	16.538

*The juices analyzed were from the stalks from which these leaves were taken.

Analyses of leaves of sorghum—Continued.

Date.		Variety.	Per cent. glucose.	Per cent. sucrose.	Per cent. ash in alcohol extract.	Per cent. total ash.	Per cent. moisture.
Sept.	27	African canes	.50	4.25	2.31	11.25	4.70
Oct.	18	White Liberian (Leaming)	2.00	2.40	1.53	12.05	4.05
	18	Early Amber	1.50	3.75	1.23	8.85	4.10
	18	Link's hybrid	2.25	5.00	2.04	8.55	3.55
		Average	1.56	3.85	1.78	10.175	4.10

ANALYSES OF BEGASSES FROM SORGHUM.

The following table gives the analyses of twenty samples of begasses from nine varieties of sorghum; also, for purpose of comparison, analyses of the juices expressed from the canes.

Excluding the analyses Nos. 364 and 365 as not being comparable with the others, the average result of the proximate analyses is as follows:

AVERAGE COMPOSITION OF EIGHTEEN BEGASSES.

	Per cent.
Ether extract (fats, chlorophyll, &c)	1.43
Alcohol extract (sugars, salts, &c.)	20.75
Water extract (soluble albuminoids, gum, &c.)	1.48
Insoluble matter (fibre, silica, &c.)	76.34
	100.00
Albuminoids (N., × 6.25)	3.17
Crude fibre	23.19
Sucrose	9.94
Glucose	3.84
Ash	2.77
Water	4.41
Undetermined	52.68
	100.00

The average percentage of juice and begasse obtained and the composition of the juice was as follows:

	Per cent.
Juice expressed	57.61
Begasse	42.39
Water in begasse	54.24
Dry begasse	45.76
Sucrose in juice	12.92
Glucose in juice	1.29
Solids not sugar in juice	2.94
Polarization of juice	12.72

Specific gravity of juice, 1.0726.

Analyses of canes, juices, and begasses.

ANALYSES OF CANES AND JUICES.

Date.		Variety.	Number of analysis of juice.	Per cent. of juice.	Specific gravity.	Per cent. of glucose	Per cent. of sucrose.	Per cent. of solids, not sugar.
Sept.	14	New variety (H. S. Coll)	158	62.27	1.068	1.15	11.79	3.26
	14	White Liberian (Nesbit)	161	60.32	1.072	.93	13.81	3.28
	21	New variety (H. S. Coll)	233	54.09	1.061	1.06	12.18	1.57
	21	White Liberian (Nesbit)	235	62.35	1.074	.98	13.83	2.65
	23	New variety (H. S. Coll)	*252–5	60.15	1.063	1.05	10.79	3.34
	23	White Liberian (Nesbit)	*256–9	56.82	1.068	.88	12.04	3.28
Oct.	3	Suckers from rows 2, 3, 4, 5	364	62.02	1.022	2.04	.66	2.53
	3	Leaves from rows 2, 3, 4, 5	365	37.03	1.025	1.40	.27	4.45
	10	Neeazana	482	57.55	1.075	1.75	13.00	3.79
	11	Link's hybrid	498	61.31	1.074	.69	14.27	2.71
	12	White Liberian (Nesbit)	514	57.89	1.068	.94	11.81	3.07
	13	White Liberian (Leaming)	530	58.86	1.070	.72	12.14	3.68
	18	White Liberian (Leaming)	605	49.95	1.068	1.14	12.11	2.77
	18	Early Amber	606	63.61	1.070	1.00	13.18	2.60
	18	Link's hybrid	607	56.47	1.080	.46	15.41	3.26
	30	West India	760	57.92	1.078	2.04	13.62	2.40
	31	Red sorgho	773	59.01	1.072	1.27	12.34	3.17
Nov.	1	West India	793	59.37	1.076	2.04	13.14	2.35
	2	West India	809	59.85	1.074	1.73	12.51	(†)
Dec.	8	New variety (R. Haswell)	1126	39.25	1.095	3.34	15.17	2.61
		Average		57.61	1.0726	1.29	12.92	2.936

Date.		Variety.	Per cent. polarization.	Per cent. of begasse.	Weight of fresh begasse.	Weight of dry begasse.	Per cent. of water in begasse.	Per cent. of dry begasse.
Sept.	14	New variety (H. S. Coll)	12.06	37.73	554	257	53.61	46.39
	14	White Liberian (Nesbit)	13.60	39.68	472	214	54.66	45.34
	21	New variety (H. S. Coll)	11.16	45.91	405	176	56.54	43.46
	21	White Liberian (Nesbit)	13.65	37.65	484	238	50.83	49.17
	23	New variety (H. S. Coll)	10.61	39.85	309	150	51.46	48.54
	23	White Liberian (Nesbit)	12.25	43.18	314	152	51.59	48.41
Oct.	3	Suckers from rows 2, 3, 4, 5	1.31	37.98	649	225	65.33	34.67
	3	Leaves from rows 2, 3, 4, 5	— .08	62.97	546	187	65.75	34.25
	10	Neeazana	13.27	42.45	565	262	53.63	46.37
	11	Link's hybrid	14.21	38.69	522	225	56.90	43.10
	12	White Liberian (Nesbit)	11.38	42.11	434	205	52.76	47.24
	13	White Liberian (Leaming)	12.49	41.14	448	212	52.68	47.32
	18	White Liberian (Leaming)	11.81	50.05	552	260	52.93	47.07
	18	Early amber	12.64	36.39	514	233	54.67	45.33
	18	Link's hybrid	15.45	43.53	520	255	50.96	49.04
	30	West India	12.93	42.08	478	201	57.95	42.05
	31	Red sorgho	12.71	40.99	483	219	54.66	45.34
Nov.	1	West India	12.57	40.63	448	192	57.14	42.86
	2	West India	12.52	40.15	447	191	57.27	42.73
Dec.	8	New variety (R. Haswell)	13.72	60.75	664	292	56.02	43.98
		Average	12.72	42.39			54.24	45.76

* Inclusive. † Lost.

Analyses of canes, juices, and begasses—Continued.

ANALYSES OF DRIED BEGASSES.

Date.		Variety.	Number of analysis of begasse.	Per cent. ether extract.	Per cent. alcohol extract.	Per cent. water extract.	Per cent. insoluble residue.	Per cent. nitrogen multiplied by 6.25.
Sept.	14	New variety (H. S. Coll)	1300	1.84	19.96	1.37	77.33	2.813
	14	White Liberian (Nesbit)	1301	1.25	18.33	1.84	78.58	3.125
	21	New variety (H. S. Coll)	1304	1.20	18.25	1.58	78.97	2.813
	21	White Liberian (Nesbit)	1305	1.72	20.97	1.60	75.71	3.125
	23	New variety (H. S. Coll)	1308	1.07	20.52	1.46	76.95	2.813
	23	White Liberian (Nesbit)	1309	1.17	19.50	1.21	78.12	3.000
Oct.	3	Suckers from rows 2, 3, 4, 5	1312	2.20	11.78	1.08	84.94	5.625
	3	Leaves from rows 2, 3, 4, 5	1313	5.26	12.70	1.47	80.87	13.125
	10	Neeazana	1316	1.75	23.17	1.34	73.74	3.000
	11	Link's hybrid	1318	1.55	23.27	1.55	73.63	3.5000
	12	White Liberian (Nesbit)	1320	1.28	17.83	1.79	79.10	3.000
	13	White Liberian (Leaming)	1322	1.57	17.68	.90	79.85	3.125
	18	White Liberian (Leaming)	1324	1.19	22.22	1.71	74.88	4.000
	18	Early amber	1326	1.55	21.26	1.39	75.80	2.125
	18	Link's hybrid	1328	1.43	19.18	1.58	77.81	3.125
	30	West India	1330	1.52	22.92	1.37	74.19	3.313
	31	Red sorgho	1331	1.22	19.51	1.17	78.10	3.125
Nov.	1	West India	1332	1.85	22.95	2.02	73.18	3.500
	2	West India	1333	1.49	22.17	1.38	74.96	4.000
Dec.	8	New variety (R. Haswell)	1336	1.11	24.34	1.32	73.23	3.500
		Average	....	1.43	20.75	1.48	76.35	3.167

Date.		Variety.	Per cent. crude fiber.	Per cent. glucose.	Per cent. sucrose.	Per cent. ash in alcohol extract.	Per cent. total ash.	Per cent. moisture.
Sept.	14	New variety (H. S. Coll)	27.475	3.25	9.75	.84	2.70	4.25
	14	White Liberian (Nesbit)	21.875	4.25	7.10	.93	2.60	3.75
	21	New variety (H. S. Coll)	21.600	3.25	8.80	.88	2.55	4.00
	21	White Liberian (Nesbit)	21.050	3.75	7.40	1.03	2.95	4.65
	23	New variety (H. S. Coll)	20.775	2.75	10.45	.87	3.05	5.20
	23	White Liberian (Nesbit)	21.475	3.75	7.60	1.00	2.80	4.55
Oct.	3	Suckers from rows 2, 3, 4, 5	25.525	2.00	.95	1.58	4.10	3.95
	3	Leaves from rows 2, 3, 4, 5	20.250	1.25	.50	1.82	5.90	3.95
	10	Neeazana	21.100	5.50	10.00	.74	3.00	4.40
	11	Link's hybrid	23.725	6.75	7.10	1.20	3.00	4.90
	12	White Liberian (Nesbit)	19.975	....	10.00	.89	2.50	5.15
	13	White Liberian (Leaming)	25.550	3.50	....	.94	2.85	3.80
	18	White Liberian (Leaming)	22.025	2.75	13.50	1.04	2.70	5.65
	18	Early amber	22.625	2.50	12.75	.97	2.20	5.00
	18	Link's hybrid	23.975	3.00	9.50	.89	2.95	4.30
	30	West India	24.400	4.50	8.00	.87	2.75	4.75
	31	Red sorgho	25.750	3.25	10.50	1.16	2.60	4.20
Nov.	1	West India	23.150	4.25	11.75	1.02	2.95	3.10
	2	West India	23.975	4.75	10.25	.77	2.55	4.45
Dec.	8	New variety (R. Haswell)	26.950	3.50	14.50	1.23	3.20	3.35
		Average	23.192	3.84	9.94	.96	2.77	4.41

LOSS OF SUGAR IN THE BEGASSE.

The most important point established by these analyses is the very considerable loss of sugar, owing to the impossibility of a mill to express all the juice. We often hear of begasse as coming from the mill "perfectly dry," but it will be seen that although the juice obtained from these canes was much greater in amount (57.61 per cent.) than is

usually obtained in practice, still the average amount of water remaining in the begasse was 56.26 per cent.; and if to this we add the alcohol and water extracts of the begasse, which would naturally constitute the juice, we should have $(20.75+1.48) \times .4576 = 10.17 + 56.26 = 66.43$ per cent. of juice still remaining in the begasse; that is, 66.43 per cent. of the weight of the begasse as it came from the mill.

Surprising as this may appear to those who have not considered it, there can be no doubt but that the above is even short of the truth.

The average amount of juice obtained was 57.61 per cent., and the total sugars in the juices averaged 14.21 per cent., or 8.19 per cent. of the weight of stripped cane. The average of the dry begasses gave 13.78 per cent. of total sugars, or 6.31 per cent. of total sugars in the fresh begasses; it follows, therefore, that the begasses, as they came from the mill, contained 77.05 per cent. as much sugar as was expressed by the mill from the fresh canes.

Since there was 6.31 per cent. of total sugars in the fresh begasses, it follows that the amount of sugars in the begasse equalled 2.67 per cent. of the weight of the stripped cane; also, as the total sugars in the expressed juice was 14.21 per cent., it follows that the amount of sugars in the juices equalled 8.19 per cent. of the weight of the stripped cane, and therefore the total sugars in the stripped cane was equalled to 10.86 per cent. of the weight of the cane, and there was lost in the begasse 24.62 per cent. of the total sugars present in the cane.

That this estimate falls short of the truth is obvious when we consider that the juices were analyzed the day they were expressed, while the begasses in drying had lost much of their sugar through fermentation, as was seen to be true in the analyses of the fresh juices as compared with the analyses of the same juices when dried.

Since the water contained in the plant is far more than sufficient to hold in solution all the sugars present, there appears no good reason to doubt that the juice left in the begasse is identical in its composition with that expressed; but, if we examine the average results of the analyses of juices and begasses in the table, we find that the per cent. of sucrose in the total sugars of the juices was 90.92, while in the begasses it was 72.13; while if we examine certain of the analyses we find a discrepancy still greater; for example, analysis No. 498 of the juice and begasse of Link's hybrid give us in the juice 95.39 per cent. of sucrose and 4.61 per cent. of glucose in the total sugars, while the analysis of the begasse from this cane shows the two sugars to be in this ratio: glucose, 48.74 per cent.; sucrose, 51.26 per cent.

Such a result is, beyond question, due to the fact that during the process of drying the begasses there had been an inversion of much of the sucrose, and in all probability a loss of glucose by fermentation.

Prof. George H. Cook, director of the New Jersey Agricultural Experimental Station, at New Brunswick, in the report on his work, alludes to the waste in the use of the ordinary mills for extracting the juice,

and estimates the loss as being equal to 40 per cent. of the sugar present in the cane.

When we consider the magnitude of this industry, this estimated loss assumes immense proportions. Fully $300,000,000 worth of sugar is now annually produced from cane by practically the same methods used in the production of sorghum sugar. According to the estimate of Professor Cook, then, it appears that there is annually lost in the begasse two-thirds as much, or $200,000,000 worth of sugar. It would appear most desirable that some method be devised by which this enormous waste may be prevented.

EXPERIMENTS IN RECOVERING SUGAR FROM THE BEGASSE.

Some experiments have been made at the Department with a view to recover from the begasse the sugar it contained. The apparatus consisted of a series of barrels so arranged that, having been filled with begasse, water was allowed to flow in at the top until the barrel was full, and then by means of a pipe leading from the bottom of the barrel the water flowed over into a second, and thence to a third barrel, and so on. The overflow from the successive barrels was taken when it first ran off, and the following tables will show the results secured in a large number of experiments:

	Number of experiments.	Specific gravity of juice.	Total sugars.
			Per cent.
First barrel	13	1.0086	1.34
Second barrel	13	1.0185	3.60
Third barrel	13	1.0252	5.08
Fourth barrel	14	1.0309	6.40
Fifth barrel	17	1.0329	7.09
Sixth barrel	18	1.0356	7.17
Seventh barrel	18	1.0379	8.24
Eighth barrel	18	1.0407	8.58
Ninth barrel	19	1.0422	8.29
Tenth barrel	6	1.0453	9.25
Eleventh barrel	4	1.0450	9.35
Twelfth barrel	4	1.0475	9.10
Thirteenth barrel	2	1.0470	9 78
Fourteenth barrel	2	1.0480	....
Fifteenth barrel	2	1.0480	....

From the above experiments it will be seen that the water, as it gradually passed through successive barrels of begasse, increased very regularly in density and in its content of sugar, and it was found that after about four barrels of water had passed slowly through the begasse that the water thereafter passed through without taking up any sugar; that is, the begasse had been entirely exhausted of its sugar.

It was found as the average of nine experiments that it was possible to recover 8.12 per cent. of the weight of the begasse taken in sugars, and that by these successive leachings there was obtained ultimately a juice as rich in sugar as was the juice expressed from the cane by the mill.

The begasses experimented upon were not of good cane, but the leach-

ings were found to compare favorably with the juices expressed from the cane by the mill.

The importance of this matter is such as to justify further experiment in this direction. From the above average results it would appear that a per cent. of sugar may be recovered from the begasse nearly equal to that which is expressed in juice even by our best mills.

It is also to be observed that even after this leaching the begasse may be used for purpose of fuel or for the manufacture of paper pulp, and that for this latter the exhaustion by water the better fits it for such use.

A sample of pulp made from the begasse of sorghum was submitted for examination to one of the largest paper-makers of the United States, and was by him said to be worth 4½ cents per pound.

BEGASSE AS FOOD.

By reference to the preceding tables giving the analyses of the begasses it will be seen that that their average composition when dry is as follows:

	Per cent.
Water	4.41
Crude fibre	23.19
Ash	2.77
Albuminoids	3.17
Carbhydrates	66.46
	100.00

And that of the non-nitrogenous matter, or carbhydrates, 13.76 per cent. is sugar.

Or, calculated to the fresh begasse as it came from the mill:

	Per cent.
Crude fibre	10.61
Ash	1.27
Albuminoids	1.45
Carbhydrates	30.41
Water	56.26
	100.00

And of the carbhydrates 6.30 per cent. was sugar.

Now, in accordance with the general method of estimating the relative values of different fodders, we find that these fresh begasses possess a a low nutritive ratio, about 1 to 21.

In Annual Report, 1879, page 57, two analyses of Honduras and Early Amber begasses and leaves were made with the following results:

	Begasses.	Leaves.
	Per cent.	*Per cent.*
Crude fibre	19.88	18.25
Ash	3.78	11.79
Albuminoids	3.92	14.79
Non-nitrogenous	72.42	55.17
	100.00	100.00
Nutritive ratio	1:18.47	1:4.68

Now this year, as the average of eleven experiments, where many stalks were taken, and of several varieties of sorghum, it was found that the ratio of stripped cane to the leaves was as 5.5 to 1, and as we have seen that the relative proportion of stripped cane to the begasse was as 100 to 42.39, it follows from our experiments that there would be an average of 23.31 pounds of begasse to 10 pounds of leaves, and that the average composition of the mixture of these two in that proportion in which they normally occur could be readily determined as follows:

Average analyses of fresh begasses and leaves.

	Average of 18 begasses.	Average of 4 leaves.
	Per cent.	*Per cent.*
Crude fibre	10.61	4.61
Ash	1.27	2.84
Albuminoids	1.45	3.79
Carbhydrates	30.41	15.49
Water	56.26	73.27
	100.00	100.00

If, now, we multiply the constituents of the begasse by 23.31, and add to ten times those of the leaves, and divide by 33.31, we have as the composition of the mixture of fresh leaves and fresh begasse, which would be produced from the cane yielding the leaves:

	Per cent.
Crude fibre	8.80
Ash	1.74
Albuminoids	2.15
Carbhydrates	25.93
Water	61.38
	100.00
Nutritive ratio	1:12

The average analyses of 26 specimens of ensilage, published in the Annual Report for 1881–'82, page 572, and of two specimens of maize cut at the period when it would generally be used for the purpose of ensilage, are interesting in this connection, and are as follows:

Average analysis of ensilage and maize.

	Average of 26 samples ensilage.	Average of 2 samples corn stalks in silk.
	Per cent.	*Per cent.*
Crude fibre	5.99	4.24
Ash	1.33	1.16
Albuminoids	1.37	1.19
Carbhydrates	10.08	10.48
Fat	.79	.57
Water	80.44	82.36
	100.00	100.00
Nutritive ratio	1:7.9	1:9.3

If, now, we assume the following values to the several nutritive constituents of these materials, viz:

	Cents per lb.
Albuminoids	3.40
Fats	2.93
Carbhydrates	.72

we should have for a ton of 2,000 pounds of each of the above the following values:

Money values in 2,000 pounds.

	Average ensilage.	Maize stalks.	Begasse and leaves.
Albuminoids	$0 93	$0 81	$1 46
Fats	46	33	62
Carbhydrates	1 45	1 51	3 58
Total	2 84	2 65	5 66

It would appear, then, that this mixture of leaves and begasse, as it comes from the mill, has a feeding value just twice as great as the average of the 26 specimens of ensilage, and it is, therefore, most desirable that careful and repeated experiments be made for its preservation as fodder, especially in silos. Owing to the disintegration of the stalk and the rupture of the cells of the plant, the begasse is in such a condition as to rapidly enter into fermentation, and it would be necessary, therefore, to remove it as speedily as possible from the action of the air by compressing it in silos; but, owing also to this thorough crushing of the hard coating of the cane, the begasse would appear to be in excellent condition for eating and the nutritive constituents would the more readily be digested and assimilated.

By general testimony begasse is found, when fresh, to be greedily eaten by most stock, and cattle have been known, during the winter, to burrow and eat far into a pile of begasse, the interior of the heap being obviously in the condition which it would have been if preserved in a silo.

The disposition to be made of the begasse is, on many accounts, the most important question connected with the sorghum-sugar industry.

The sugar of the plant, as is well known, is derived ultimately from the atmosphere, containing, except as an impurity, not a trace of mineral matter. It would be possible, therefore, to produce upon our lands a sugar supply for the world indefinitely without exhausting the soil; indeed, the soil would gradually increase in fertility under cultivation.

But when we consider the remainder of the plant, the seed, the leaves, and the begasse, we find that for their production large demands are made upon the soil, a demand practically the same as for the production of an equal weight of maize.

Of course, if the cane is stripped for the mill the leaves are either left upon the field or are preserved as food for animals, and with the

proper preservation and use of the manure of the farm no loss to the fertility of the soil could result from this source.

In regard to the seed, it is most likely that it will be largely consumed upon the farm, especially since its value for feeding stock has been experimentally proven by Professor Cook, of the New Jersey Experimental Station, to be practically the equivalent of maize. Until, therefore, the seed of sorghum shall reach a wholesale price in the market approximately equal to maize, it is more than likely that the farmer will use his sorghum seed as food for his farm animals, and thus secure its consumption upon the farm, returning to his fields the mineral matter which the seed also has removed in its growth.

There remains, therefore, only the begasse and the sediments and scums of the sugar-house which could possibly prove a source of exhaustion to the soil. The importance of adding the sediment and scum obtained in defecation to the land directly or to the manure or compost heap has already been alluded to. Such disposition of these unsightly products is easy and would naturally suggest itself to the ordinary farmer.

An experiment made at the Department showed that by piling up the begasse, with the addition of quicklime or solution of potash, caused the pile during the winter to become thoroughly disintegrated, so that it could easily be added to the land, as manure, and by the plow and harrow readily incorporated with the soil.

In those sections where scarcity of fuel exists, the utilization of the begasse for such purpose is likely to increase, but it is of great importance that the ashes produced should be carefully saved and applied to the soil, since it is only these constituents of the begasse derived from the atmosphere which would burn or could serve the purpose of fuel.

The mineral matter necessary to the production of a crop of sorghum equal to 11 tons of stripped stalks to the acre would be as follows: 11 tons of stripped cane would give at 42.39 per cent. begasse, 4.66 tons of begasse and 6.34 tons of juice. The relative proportion of leaves to stripped cane is, as we have seen, about 1 to 5.5, and therefore we should have 2 tons of leaves. A crop of 25 bushels of seed would not be disproportionate to such a yield of cane, which, at 56 pounds to the bushel, would be 1,440 pounds. The average per cent. of ash in sorghum juices we have found to be about 1.0 per cent., Agricultural Report, 1880, p. 125. We should have, therefore, as the total mineral matter taken from the soil by a crop of 11 tons of stripped cane the following:

Ash in a crop of 11 tons of stripped cane.

	Pounds.
4.66 tons begasse, at 1.27 per cent	93.2
6.34 tons juice, at 1.00 per cent	126.8
2.00 tons leaves, at 2.84 per cent	113.6
1400 pounds seed, at 1.68 per cent	23.5
Total	357.1

The constituents of the ash from the several portions of the plant is not known, but the analysis of the ash of two samples of the entire cane is given, Agricultural Report, 1880, p. 126, and the analysis of the ash of the seed closely resembles that of maize. If, therefore, we calculate the amount of these several constituents of the ash upon such basis, we have in the 357.1 pounds above as follows:

	Pounds.
Potash	180.8
Soda	.9
Lime	36.6
Magnesia	37.1
Iron oxide	.2
Phosphoric acid	24.2
Sulphuric acid	28.9
Chlorine	28.2
Silica	19.9
	357.1

EXPERIMENTS IN DEFECATION.

During the past season there have been made, in all, seventy-eight experiments in defecation, using the following reagents: Hydrate of lime, calcium sulphite, and a mixture of these two. The results of these experiments are given in detail in the following tables:

In Table A is given the variety of sorghum used in each experiment, and it will be seen that the new African varieties were used in eight of the experiments, the new varieties from India in five experiments, and different varieties grown in this country for the remaining sixty-five experiments.

In each case, for purpose of comparison, the analysis of the juices is given. In most cases each sample of juice analyzed was used for several experiments in defecation, and the sirups in each case were also analyzed.

In Table B the details of each experiment is given, and the character of the different sirups produced.

In Table C are given details of fourteen experiments in defecation of the juice and manufacture of sirup and sugar which were carried through quantitatively.

By reference to Table A it will be seen that the average composition of the juices in the seventy-eight experiments, and of the sirups made from them, is as follows:

	Juices.	Sirups.
Per cent. sucrose in total solids	76.06	81.88
Per cent. glucose in total solids	8.38	7.56
Per cent. solids, not sugar, in total solids	15.56	10.58
Per cent. available sugar in total solids	52.13	63.81

From the above it appears that in the preparation of these sirups there was an increase of 7.65 per cent. in the relative amounts of sucrose,

and of 22.45 per cent. in the relative amounts of available sugar over the relative amounts present in the juices from which the sirups were made, while there was a relative decrease of 9.79 per cent. in the glucose, and of 39.20 per cent. in the solids not sugar.

As it is, for the purpose of sugar production, most desirable to decrease as much as possible the relative amounts of glucose and other solids not sugar in the sirups, or, what is equivalent, to increase the amount of sugar in a sirup, the above results are obviously very satisfactory. But these results do not show what proportion of the sugar present in the juice was actually recovered in the several sirups.

In Table C it will be seen that as an average of the fourteen experiments there was found of each constituent in the several juices and in the sirups made from them the following parts by weight:

	In juices.	In sirups.
Sucrose	1,151	1,036
Glucose	149	108
Solids, not sugar	224	128
Available sugar	778	800

In other words, there was a loss of 10 per cent. of the sucrose, of 27.52 per cent. of the glucose, and of 42.86 per cent. of the solids not sugar; and a gain of 2.83 per cent. in the amount of available sugar present in these sirups as compared with the actual amounts present in the juices from which they were made.

The recovery, then, of 90 per cent. of the amount of sugar present in the juices of sorghums, and an actual increase in the amount of available sugar, is conclusive evidence that these juices may be manipulated with as great economy as are the juices of sugar-cane, if only due care be exercised.

Of course, this loss of 10 per cent. of the sugar is due to such portions as are lost in the scum and sediments of defecation, and in the skimming necessary during the evaporation to sirup. As these experiments were necessarily upon a very small scale, using rarely for each experiment more than a quart of juice (since, as has been mentioned, our entire plat of sorghum of sixty-four varieties only equaled two-ninths of an acre), it is fair to presume that the losses sustained by working such small amounts were much greater in proportion than would be necessary when working with larger quantities.

By reference to page 61 of the annual report for 1879 it was said as the result of certain experiments that year:

> We may hope, then, to secure in sirup 90 per cent. of the crystallizable sugar present in the juices operated upon.

And in the annual report for 1881–'82, page 500, it is said of the experiments made in 1881:

> The results show that in the forty experiments made the amount of sucrose recovered in the sirups was 87.5 per cent. of the actual amount in the juice.

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	JUICE.		
Development.	Per cent. of juice.	Specific gravity.	Per cent. of glucose.
Seed hard, sucker in dough	49.95	1.068	1.14
......do	63.61	1.070	1.00
....	....	1.072	1.53
Seed hard, sucker in dough	57.92	1.078	2.04
Seed hard, sucker in dough	59.01	1.072	1.27
Seed hard, sucker in dough	59.37	1.076	2.04
Seed hard, sucker in dough	59.85	1.074	1.73
Seed hard, sucker in dough	59.15	1.078	1.72
Seed hard, sucker in hard dough....	58.28	1.079	1.85
Seed hard, sucker in hard dough....	58.64	1.079	2.12
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TABLE B.—*Experiments in defecation.*

No. of analysis.	How defecated.	Neutral or alkaline.	Scum.	Character of precipitate.	Precipitate settled or not.	Juice after defecation.	Juice before sirup.	Character of sirup.	Character of sugar in December.	Remarks.	Scum while evaporating.
708	$CaSO_3$		Scum	Light; flocculent	Not settled without water.	Light green		Light amber color			Green.
761	$CaSO_3$		Heavy	Very light; flocculent.	Settled well	Yellowish green		Light brown color			Little.
762	$CaSO_3$		do	Light; flocculent		do		Light amber color		White precipitate at 80°C; second defecated juice neutralized with $Ca(OH)_2$.	None.
763	Mixture	Strongly alkaline	do	Heavy	Settled well	Dark wine color		Dark color			
778	$CaSO_3 + Ca(OH)_2$	Neutral	do	do	do	Dark brown color		Brown color		Enough $Ca(OH)_2$ used to neutralize.	
779	$CaSO_3 + CaO$	do	do	Light; flocculent	do	do		Dark color			
780	$CaSO_3$	do	Scum	do	Settled	Yellowish green		Turbid; yellow		Defecated juice treated with $Ca(OH)_2$ gave heavy white precipitate.	None.
781	$CaSO_3$		Heavy	do	Not settled	do		Clear; light brown		Heavy white precipitate settled at once after neutralizing with $Ca(OH)_2$.	Do.
782	$CaSO_3$		do	do	Not until neutralized	do		do		Heavy precipitate after adding $Ca(OH)_2$.	Do.
794	$CaSO_3$	Neutralized after defecation.	do	do	do	Turbid; gray		do		do	White.
795	$CaSO_3$	do	do	do	do	Grayish brown		Light brown		do	Scum.
796	$CaSO_3$	do	do	Heavy; whitish green	do	Turbid; grayish brown		Turbid; yellowish		do	
810	Mixture	Slightly alkaline	do	Heavy; light green	Settled at once	Dark brown	Acid	Clear; light brown			Scum.
811	do	Neutral	do	do	do	Clear; light brown	Very acid	do			
812	do	Slightly alkaline	do	Light green	do	Clear; dark brown	Acid	Slightly turbid; dark brown			
813	$CaSO_3$ + mixture	do	do	Very light precipitate	Settled well	Dark brown	do	Light brown color			
822	Mixture	do	do	Light; flocculent	do	Clear; dark brown	Slightly acid	Clear; light amber	Clear sirup; very few small crystals; long xx.		
823	do	do	do	do	do	do	do	do	do		
824	do	Neutral	do	Very light; flocculent	Settled well	Turbid; light brown	Acid	Clear; light brown	Slightly turbid; very few small crystals; long xx.		
837	do	do	do	Light; flocculent	do	Turbid; reddish brown	Strongly acid	Turbid; light amber	Slightly turbid		
838	do	Slightly alkaline	do	Light; curdy	do	Clear; light brown	do	Clear; light amber	Slightly turbid; thin		
839	do	Strongly alkaline	do	Heavy; curdy; green	do	Clear; dark brown	Neutral	Clear; dark amber	Slightly turbid; about ⅓ heavy sediment.		
840	do	do	do	do	do		do	do	Three-fifths sediment; remainder clear.		
852	do	*Strongly* alkaline	do	Light; curdy	do	Clear; dark brown	do	Clear; dark yellow	Heavy sediment; thin and clear.		
853	do	Slightly alkaline	do	do	do	Clear; brown	Slightly acid	Clear; light amber	Heavy sediment; turbid		
854	do	do	do	do	do	Clear; light brown	do	do	One-third sediment; clear; thin; light color.		
855	do	do	do	do	do	do	do	do	Sediment turbid		
867	do	Neutral	do	Light; flocculent	do	Turbid; reddish brown	Strongly acid	Bright, clear amber	Cloudy; few large radiated xx		Greenish yellow.
868	do	Strongly alkaline	do	Heavy; curdy	do	Clear; light brown	Neutral	Clear; light amber	do		White, foamy.
869	do	do	do	do	do	do	do	do	Cloudy		Do.
883	do	Neutral	do	Light; flocculent	do	Turbid; light brown	Strongly acid	Turbid; light amber	Heavy sediment; turbid		Yellowish green.
884	do	Slightly alkaline	do	Heavy; curdy	do	Clear; dark brown	Slightly acid	Clear; dark amber	Heavy sediment; slightly turbid.		Do.
885	do	Strongly alkaline	do	do	do	do	Neutral	Clear; light amber	do		Do.
896	do	Slightly alkaline	do	do	do	Clear; light brown	Slightly acid	Clear; light brown	Clear; slight sediment		Greenish white.
897	do	do	do	do	do	do	do	Clear; dark color	Clear; bright; few large radiated xx crystals.	Sirup scorched	Do.
898	do	do	do	do	do	do	do	Clear; light brown	Clear; sediment; *very* few crystals; long xx.		Do.
899	do	do	do	do	do	do	do	do	Nearly ½ sediment; remainder bright, clear.	Defecated juice stood 1½ hours before evaporation; became *dark* brown.	Do.
911	do	Neutral	Heavy; curdy	Light; flocculent	Not settled	Turbid; light brown	Strongly acid	Clear; light amber	One-half sediment; light; thin; clear.		White, foamy.
912	do	Slightly alkaline	do	Heavy; curdy	Settled well	Clear; light brown	Slightly acid	do	Half solid; very small yellowish xx; thin, clear sirup.		Clean, white, foamy.
913	do	Strongly alkaline	Very heavy	Very light; curdy	do	Clear; dark reddish brown	Strongly alkaline	Clear; dark brown	Slightly turbid; thin; dark		Thick, white.
914	do	Alkaline	do	do	do	do	Neutral	Clear; light brown	Two-thirds sediment; thin; dark.	Juice stood 1 hour before evaporating; became very dark clear brown.	White, foamy.
971	do	Slightly alkaline	Heavy	Slight; curdy	do	Clear; light reddish brown	Slightly acid	Clear; light amber	Turbid; few medium xx		Do.
972	do	do	do	do	do	do	do	do	Slightly turbid; few medium xx.		Do.
973	do	Strongly alkaline	Very heavy; curdy	Very slight; curdy	do	Clear; dark reddish brown	Neutral	do	Turbid; light; many medium large xx.		Do.
984	do	Slightly alkaline	Thick; heavy	Slight; curdy	do	Clear; light reddish brown	Slightly acid	do	Turbid; light; thin		Do.
985	do	do	do	do	do	do	do	do	Thin; slightly turbid; light clear; many large xx.		Do.
986	do	Strongly alkaline	do	Heavy; curdy	do	Dark reddish brown	Neutral	do	Thin; turbid; light color	Juice became bright	Clean, white, foamy.
996	do	Slightly alkaline	do	Slight; curdy	do	Clear; light reddish brown	Slightly acid	do	Turbid; few medium xx		White, foamy.
997	do	Strongly alkaline	do	do	do	Clear; dark reddish brown	do	do	Turbid; thin	Juice changed very light	Do.
998	do	do	do	do	do	do	do	do	Sediment; turbid; very large xx.	do	Do.
1009	do	do	do	Light; flocculent	Not settled	Clear; light reddish brown	Alkaline	Clear; dark brown	One-third sediment; slightly cloudy.	Defecated juice became dark brown on standing 1 hour.	Do.
1010	do	do	Heavy	do	do	do	do	do	do	do	Do.
1011	do	Slightly alkaline	Thick; heavy	Light; curdy	Settled well	do	Slightly acid	Clear; light amber	Slightly turbid; small sediment.	N. B.—Juice for 1009, 1010, and 1011 gave sour smell.	Do.
1022	do	do	Very heavy	Slight; curdy	do	Clear; *light* brown	Acid	Clear; *light* amber	Solid; yellowish; very small xx		Clean, white, foamy.
1023	do	do	Heavy	Heavy; curdy	do	do	do	do	Very light; clear; semi-solid medium xx.		Do.
1024	do	do	Very heavy	do	do	do	do	do	Light clear; almost solid medium xx.		Do.
1046	do	do	Heavy	Slight; curdy	do	Clear; light reddish brown	Slightly acid	Very clear; light amber	*Solid*; small xx		Do.
1047	do	Strongly(?)alkaline	Thick; heavy	Heavy; curdy	do	do	do	Clear; light amber	Clear; bright; almost solid medium xx.		Do.
1048	do	Slightly alkaline	Heavy	Slight; curdy	do	do	do	do	Clear; bright; ⅛ full large xx.		Do.
1059	do	Neutral	do	do	do	Clear; light brown	Acid	Clear; *light* amber	Solid; clear; yellowish; small xx.		Do.
1060	do	Strongly alkaline	do	Very heavy; curdy	do	do	Slightly alkaline	do	Bright; clear; many large xx		Do.
1061	do	Slightly alkaline	do	Slight; curdy	do	do	Slightly acid	do	Very light; clear; semi-solid medium xx.		Do.
1072	do	do	do	Heavy; curdy	do	Turbid; light brown	Acid	Turbid; light brown	Slightly cloudy; ⅜ full medium small xx.	About half defecated juice lost in precipitate.	Yellowish green.
1073	do	do	do	do	do	do	do	do	Slightly cloudy; ⅜ full *small* xx.	do	Do.
1074	do	Strongly(?)alkaline	do	do	do	Slightly turbid; light brown	Slightly acid	do	Clear; light color; large xx	do	Do.
1085	do	Slightly alkaline	do	Very heavy	do	Clear; light brown	do	Clear; dark brown; scorched	Clear; solid; medium xx	do	Greenish white.
1086	do	Strongly alkaline	do	Very heavy; curdy	do	do	Slightly alkaline	Turbid; light brown	Clear; bright; semi-solid small xx.	do	Do.
1087	do	Strongly(?)alkaline	do	do	do	do	Slightly acid	Clear; light brown	Semi-solid; very small xx	do	Do.
1094	do	Strongly alkaline	do	*Very* heavy; curdy	do	Clear; dark brown	Slightly alkaline	Clear; light amber	Solid; yellowish; very fine small xx.	do	White, foamy.
1095	do	Alkaline	do	do	do	do	do	do	Clear; light; ½ full medium xx.	Part of defecated juice lost in precipitate.	Do.
1096	do	Neutral	Scum	Heavy; curdy	do	Clear; light brown	Acid	do	Semi-solid; yellowish; *very* fine small xx.		Clean, white, foamy.
1103	do	Slightly alkaline	Heavy	*Very* heavy	do	do	do	Clear; light brown	Solid; small xx	Part of juice lost in precipitate.	Do.
1104	do	do	do	do	do	do	do	do	Clear; bright; almost solid small xx.	do	Do.
1110	do	Strongly alkaline	do	do	do	Dark red	Slightly alkaline	Dark brown	Clear; dark; nearly solid; small xx.	do	Do.
1111	do	Slightly alkaline	do	do	do	do	Slightly acid	Turbid; brown	Solid; small xx; dark color	do	Do.
1112	do	do		Very heavy	do	do	Neutral	Clear; dark brown	do	do	Do.

...ka-	Scum.	Character of precipitate.	Precipitate set...
......	Scum	Light; flocculent	Not settled wi...
......	Heavy	Very light; flocculent.	Settled well
......	....do	Light; flocculent	....
...line..	...do	Heavy	Settled well
......	....do	......do	......do
......	...do	Light; flocculent	......do
......	Scum	......do	Settled
......	Heavy	......do	Not settled
......	...do	......do	Not until neut...
after	....do	......do	......do

...nt. ...p ...e.	Character of sirup.
...3	....
...3	XX sol.
...3	XX few.
...8	XX sol.
...6	XX sol.
...8	XX sol.
...1	XX sol.
...3	XX $\frac{2}{3}$.
...8	XX sol.
...0	XX sol.
...6	XX sol.
...4	XX $\frac{2}{3}$.
...1	XX sol.
	XX sol.

There remains only to speak of the character of the sirups produced in the seventy-eight experiments of this year. In Table B a column is given which describes the physical character of the several sirups made, and, as will be seen, in nearly every case crystals of sugar were present, while in a very large number the sirup was a semi-solid mass of sugar and molasses.

In the fourteen experiments which were made quantitatively, eleven of the sirups were a solid mass of crystals; in two of them two-thirds of the sirups was mush sugar; and in the remaining sample the sirup contained a few crystals of sugar, but the analysis showed that this one had not been evaporated quite to the point of good crystallization. All of the seventy-eight experiments were made by open-pan evaporation.

As evidence of the character of the juices used in these fourteen experiments it will be seen that their average analysis was:

Specific gravity, 1.0786.

	Per cent.
Sucrose	13.646
Glucose	1.696
Solids not sugar	2.632
Polarization	13.048
Available sugar	9.298

and the per cent. of sirup made from the juices averaged 20.85.

The average composition of the juices used in the 78 experiments was as follows:

Specific gravity, 1.077.

	Per cent.
Sucrose	13.55
Glucose	1.15
Solids not sugar	2.77
Polarization	13.28
Available sugar	9.29

SIRUPS AND SUGAR FROM THE NEW CHINESE SORGHUMS.

Although, as has been seen, the new varieties of sorghum from China were far inferior as sugar-producing plants to those received from India, Africa, or those grown in the United States, and those sending the seed confidently assured Minister Angell that there was no sugar to be obtained from these varieties, an experiment was made with the stalks of all of the six kinds, except No. 1 (which had been cut down), upon September 16, with the following results:

Stalks, with tops and leaves	pounds	290
Stripped stalks obtained	do	160
Loss by topping and stripping	per cent	44.83
Juice expressed	pounds	76
Juice in stripped stalks	per cent	47.50
Juice lost	pounds	19
Sirup made from 57 pounds juice	do	9
Sirup in juice	per cent	15.79

TABLE A.—*Experiments in defecation.*

JUICE.

No. of analysis.	Variety.	Development.	Per cent. of juice.	Specific gravity.	Per cent. of glucose.	Per cent. of sucrose.	Per cent. of solids not sugar.	Polarization, per cent.	Per cent. of available sugar.	Per cent. of sucrose in total solids.	Per cent. of glucose in total solids.	Per cent. of solids not sugar in total solids.	Per cent. of available sugar in total solids.
605	White Liberian	Seed hard, sucker in dough	49.95	1.068	1.14	12.11	2.77	11.81	8.20	75.59	7.12	17.29	51.18
606	Early Amber	do	63.01	1.070	1.00	13.18	2.60	12.64	9.58	78.54	5.96	15.49	57.09
707	Mixed juices from rows 25, 33, 34		....	1.072	1.53	12.98	1.16	12.44	10.29	82.83	9.76	7.40	65.67
760	West India	Seed hard, sucker in dough	57.92	1.078	2.04	13.62	2.40	12.93	9.18	75.42	11.29	13.29	50.84
773	Red Sorgho	Seed hard, sucker in dough	59.01	1.072	1.27	12.34	3.17	12.71	7.90	73.54	7.57	18.89	47.08
793	West India	Seed hard, sucker in dough	59.37	1.076	2.04	13.14	2.35	12.57	8.75	74.96	11.64	13.41	49.91
809	West India	Seed hard, sucker in dough	59.85	1.074	1.73	12.51	(2.78) Lost.	12.52	(8.00)	(73.50)	(10.16)	(16.33)	47.01
821	West India	Seed hard, sucker in dough	59.15	1.078	1.72	13.55	2.90	12.96	8.93	74.57	9.47	15.96	49.14
834	West India	Seed hard, sucker in hard dough	58.28	1.079	1.85	13.47	2.88	12.91	8.74	74.01	10.16	15.82	48.03
851	West India	Seed hard, sucker in hard dough	58.64	1.079	2.12	13.28	2.69	12.85	8.47	73.41	11.72	14.87	46.82
866	West India	Seed hard, sucker in hard dough	59.24	1.074	2.29	12.09	2.75	11.88	7.05	70.58	13.37	16.06	41.05
882	West India	Seed hard, sucker in hard dough	57.46	1.078	2.06	12.87	3.27	12.66	7.54	70.71	11.32	17.97	41.42
895	West India	Seed hard, sucker in hard dough	58.62	1.074	2.09	12.34	2.68	12.07	7.57	72.12	12.21	15.66	44.25
910	New variety, E. Link	Seed hard, sucker in dough	58.72	1.079	.89	14.78	2.88	14.69	11.01	79.68	4.80	15.53	59.35
970	New variety, E. Link	Seed hard, sucker in dough	63.01	1.082	.62	15.17	3.28	15.06	11.27	79.55	3.25	17.20	59.10
983	New variety, E. Link	Seed hard, sucker in hard dough	53.63	1.082	1.73	14.20	3.18	15.19	9.29	74.31	9.05	16.64	48.62
995	New variety, E. Link	Seed hard, sucker in hard dough	53.68	1.083	.85	14.64	3.81	14.95	9.98	75.85	4.41	19.74	51.70
1008	New variety, E. Link	Seed hard, sucker in hard dough	57.93	1.072	1.50	12.62	2.50	12.22	8.62	75.94	9.03	15.04	51.87
1021	Standard, T. O. Harrell	Seed hard, sucker hard	51.63	1.080	.39	15.17	3.15	15.44	11.63	81.08	2.09	16.83	62.16
1045	Standard, T. O. Harrell	Seed hard, sucker hard	52.36	1.080	.52	15.14	3.01	15.00	11.61	81.09	2.79	16.12	62.18
1058	Standard, T. O. Harrell	Seed hard, sucker hard	48.70	1.078	.58	14.85	2.82	14.60	11.45	81.37	3.18	15.45	62.74
1071	New variety, R. Haswell	Seed hard, sucker hard	50.72	1.074	1.99	12.79	2.62	11.95	8.18	73.50	11.44	15.06	47.00
1084	Chinese Imphee, W. A. Sanders	Seed hard, sucker hard	48.45	1.078	1.95	12.98	2.96	12.49	8.07	72.54	10.90	16.55	45.09
1093	Undendeluule, Natal	Seed hard, sucker hard	48.56	1.085	1.12	15.47	2.21	14.61	12.14	82.29	5.96	11.75	64.58
1102	do	Seed hard, sucker hard	50.67	1.079	1.33	13.90	2.72	13.59	9.85	77.44	7.41	15.15	54.88
1109	Hlogonde, A. Natal	Seed hard, sucker hard	40.47	1.077	2.09	12.99	2.65	12.60	8.25	73.27	11.79	14.95	46.53
	Average		....	1.077	1.148	13.55	2.77	13.28	9.29	76.06	8.38	15.56	52.13

SIRUP.

No. of analysis.	Experiment.	Specific gravity.	Per cent. of glucose.	Per cent. of sucrose.	Per cent. of solids not sugar.	Polarization, per cent.	Per cent. of available sugar.	Per cent. of sucrose in total solids.	Per cent. of glucose in total solids.	Per cent. of solids not sugar in total solids.	Per cent. of available sugar in total solids.
623	A B	1.072	9.40	48.45	12.95	48.60	26.10	68.43	13.28	18.29	36.86
624	A B	1.070	5.65	52.30	6.45	52.41	40.20	81.21	8.77	10.02	62.42
708	......	1.070	11.30	46.74	5.20	44.31	30.24	73.91	17.87	8.22	47.82
761	A	1.066	7.34	50.62	5.84	52.50	37.44	79.34	11.50	9.15	58.69
762	B	1.070	6.10	47.03	10.15	50.87	30.78	74.32	9.62	16.04	48.66
763	C	1.069	5.20	48.07	9.17	50.38	33.70	76.98	8.33	14.69	53.96
778	A	1.076	4.00	54.34	8.70	54.43	41.64	81.06	5.96	12.98	62.02
779	B	1.071	3.80	51.11	8.69	51.68	38.62	80.36	5.97	15.66	58.73
780	C	1.071	3.65	48.69	9.94	49.81	35.10	78.18	5.86	15.96	56.36
781	D	1.072	4.35	51.16	8.69	51.84	38.12	79.69	6.77	13.54	59.38
782	E	1.074	4.30	53.39	8.07	53.62	41.02	81.19	6.54	12.27	62.38
794	A	1.071	6.25	49.64	9.19	52.16	34.20	76.28	9.60	14.12	52.56
795	B	1.073	6.50	51.49	7.87	52.81	37.12	78.18	9.87	11.95	56.36
796	C	1.071	5.75	48.69	11.68	50.38	31.26	73.64	8.69	17.66	47.29
810	A	1.072	6.85	52.87	6.76	55.57	39.26	79.53	10.30	10.17	59.06
811	B	1.068	6.75	50.59	6.70	53.22	37.14	79.00	10.54	10.46	58.00
812	C	1.068	6.20	49.50	8.10	52.33	35.20	77.59	9.72	12.69	55.18
813	D	1.064	6.05	46.98	6.93	48.84	34.00	78.35	10.09	11.56	56.70
822	A	1.065	5.15	51.92	7.13	54.43	39.64	80.87	8.02	11.11	61.74
823	B	1.070	5.40	51.49	7.35	55.57	38.74	80.15	8.41	11.44	60.30
824	C	1.069	5.05	51.06	7.25	53.78	38.76	80.59	7.97	11.44	61.18
837	A	1.067	5.75	49.26	5.83	51.19	27.68	80.97	9.45	9.58	61.94
838	B	1.066	5.45	47.64	7.23	51.19	34.96	78.98	9.03	11.99	57.96
839	C	1.070	5.30	48.74	9.84	49.90	33.60	76.29	8.30	15.40	52.29
840	D	1.067	5.80	50.26	4.60	53.30	39.86	82.86	9.56	7.58	65.72
852	A	1.068	6.25	48.97	7.10	53.14	35.62	78.58	10.03	11.39	57.16
853	B	1.070	6.30	51.02	6.28	53.95	38.44	80.22	9.90	9.88	60.44
854	C	1.067	6.15	47.83	7.30	53.70	34.38	78.05	10.04	11.91	56.10
855	D	1.069	6.55	58.76	7.33	52.81	44.88	80.89	9.02	10.09	61.78
867	A	1.072	7.90	50.16	6.50	55.24	35.76	77.70	12.24	10.07	53.39
868	B	1.073	7.65	50.68	6.31	55.24	36.72	78.40	11.83	9.77	56.80
869	C	1.067	6.95	47.55	6.18	52.49	34.42	78.36	11.45	10.18	56.73
883	A	1.068	6.50	48.93	7.13	51.84	35.30	78.21	10.39	11.40	56.42
884	B	1.070	6.40	49.97	7.71	52.97	35.86	77.98	9.99	12.03	55.96
885	C	1.071	6.45	51.16	8.03	53.70	36.68	77.94	9.83	12.23	55.88
896	A	1.071	7.15	51.44	5.25	52.73	39.04	80.58	11.20	8.21	61.17
897	B	1.075	7.10	53.20	7.34	54.84	38.76	78.65	10.49	10.85	57.31
898	C	1.069	6.90	48.83	8.27	52.41	33.66	76.30	10.78	12.92	52.60
899	D	1.069	7.05	49.83	7.00	52.08	35.78	78.01	11.03	10.96	56.02
911	A	1.067	2.90	55.01	4.25	54.92	47.86	88.50	4.65	6.85	77.00
912	B	1.074	3.10	58.43	6.83	60.75	48.50	85.47	4.54	9.99	70.94
913	C	1.065	2.10	51.97	6.85	52.25	43.02	85.31	3.44	11.24	70.63
914	D	1.064	2.65	56.95	.92	52.33	53.38	94.10	4.38	1.52	88.20
971	A	1.068	2.05	55.15	7.00	56.86	46.10	85.91	3.19	10.90	71.82
972	B	1.069	2.05	57.43	5.24	56.70	50.14	88.74	3.17	8.09	76.48
973	C	1.070	1.90	56.91	6.11	57.92	48.90	87.66	2.93	9.41	75.32
984	A	1.067	2.30	53.68	6.82	55.24	44.56	85.48	3.66	10.86	70.90
985	B	1.072	2.45	57.81	6.66	58.64	48.70	86.39	3.66	9.95	72.78
986	C	1.065	2.30	53.39	6.55	54.11	44.54	85.78	3.70	10.52	71.56
996	A	1.070	2.15	55.91	5.38	56.70	48.38	88.13	3.39	8.48	76.26
997	B	1.070	2.15	55.72	6.09	56.70	47.48	87.14	3.36	9.52	74.26
998	C	1.072	2.15	57.62	6.51	57.83	48.96	86.92	3.26	9.83	73.83
1009	A	1.069	4.65	52.87	5.64	53.46	42.58	83.71	7.36	8.94	67.41
1010	B	1.066	4.60	50.83	6.53	51.03	39.70	82.04	7.42	10.54	64.08
1011	C	1.069	4.95	52.11	4.54	51.68	42.62	84.59	8.03	7.37	69.19
1022	A	1.081	1.40	64.03	7.37	66.42	55.26	87.95	1.92	10.13	75.90
1023	B	1.076	1.45	62.94	5.53	63.67	55.16	90.02	2.07	7.91	80.04
1024	C	1.076	1.45	63.22	6.65	64.80	55.12	88.64	2.03	9.32	77.29
1046	A	1.075	1.95	63.41	7.16	63.83	54.30	87.43	2.69	9.87	74.87
1047	B	1.075	1.65	63.70	6.57	64.80	55.48	88.57	2.29	9.13	77.15
1048	C	1.075	1.85	64.36	7.67	64.64	54.84	87.11	2.50	10.38	74.23
1059	A	1.079	2.30	66.50	6.04	66.74	58.16	88.86	3.07	8.07	77.72
1060	B	1.077	2.20	65.55	4.81	65.93	58.54	90.34	3.03	6.63	80.68
1061	C	1.078	2.40	67.55	3.77	67.31	61.38	91.63	3.25	5.11	82.27
1072	A	1.080	7.35	57.71	7.38	58.81	42.98	79.67	10.14	10.18	59.35
1073	B	1.077	7.15	56.00	7.37	55.89	41.48	79.41	10.13	10.45	58.83
1074	C	1.077	6.95	57.43	3.62	57.51	46.86	84.45	10.22	5.32	68.91
1085	A	1.076	6.75	55.53	7.00	59.13	41.78	80.15	9.74	10.10	60.31
1086	B	1.076	6.70	54.63	8.87	60.75	39.06	77.82	9.54	12.63	55.65
1087	C	1.076	6.90	54.15	9.75	60.35	37.50	76.48	9.75	13.77	52.96
1094	A	1.080	4.05	62.46	4.01	64.64	54.40	88.57	5.74	5.68	77.35
1095	B	1.076	3.80	60.71	5.93	63.02	50.08	86.19	5.39	8.42	72.38
1096	C	1.078	4.05	62.08	4.59	62.69	53.44	87.78	5.72	6.49	75.57
1103	A	1.080	5.05	63.51	4.92	66.50	53.54	86.43	6.87	6.70	72.86
1104	B	1.079	4.75	60.18	7.79	64.40	47.64	82.76	6.53	10.71	65.52
1110	A	....	7.35	58.09	10.57	56.86	40.17	76.42	9.67	13.91	62.84
1111	B	....	7.30	60.33	12.85	57.43	40.18	74.96	9.07	15.96	49.93
1112	C	....	7.65	62.65	6.77	58.89	48.23	81.29	9.92	8.78	62.59
....	....	....	3.697	54.47	7.73	55.95	42.33	81.88	7.56	10.58	63.81

Experiments in Defecation.—Table C.

No. of analysis.	Variety.	Weight of juice.	Per cent. of glucose.	Per cent. of sucrose.	Per cent. of solids not juice.	Per cent. of available sugar.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Available sugar in juice.	No. of analysis.	Weight of sirup.	Per cent. of glucose.	Per cent. of sucrose.	Per cent. of solids not sirup.	Per cent. of available sugar.	Per cent. of glucose in sirup.	Per cent. of sucrose in sirup.	Solids not sugar in sirup.	Per cent. of available sugar in sirup.	Per cent. of sirup in juice.	Character of sirup.
		788					16	101	21	64	1072	144	7.35	57.71	7.38	42.98	11	83	11	61	18.3	....
1071	New variety. R. Haswell	769	1.09	12.79	2.62	8.18	15	98	20	63	1073	158	7.15	56.00	7.37	41.48	11	88	12	65	20.3	XX sol.
		771					15	99	20	64	1074	164	6.95	57.43	3.62	46.86	11	94	6	77	21.3	XX few.
		621					12	81	18	51	1085	.129	6.75	55.53	7.00	41.78	9	72	9	54	20.8	XX sol.
1084	Chinese Imphee. W. A. Sanders	586	1.95	12.98	2.96	8.07	11	76	17	48	1086	138	6.70	54.63	8.87	39.06	9	75	12	54	23.6	XX sol.
		413					8	54	12	34	1087	94	6.90	54.15	9.75	37.50	6	51	9	36	22.8	XX sol.
		456					5	71	10	56	1094	101	4.05	62.46	4.01	54.40	4	63	4	55	22.1	XX sol.
1093	Undendelule. Natal	530	1.12	15.47	2.21	12.14	6	82	12	64	1095	118	3.80	60.71	5.03	50.98	4	72	7	61	22.3	XX $\frac{2}{3}$.
		614					7	95	14	74	1096	140	4.05	62.08	4.59	53.44	6	87	6	75	22.8	XX sol.
1162	Undendebule. Natal	501	1.33	13.90	2.72	9.85	5	70	14	51	1103	105	5.05	63.51	4.92	53.54	5	67	5	57	21.0	XX sol.
		500					7	70	14	49	1104	98	4.75	60.18	7.79	47.64	5	59	8	46	19.6	XX sol.
		585					13	76	16	47	1110	125	7.35	58.09	10.57	40.17	9	73	13	51	21.4	XX $\frac{2}{3}$.
1109	Hlogonde A. Natal	760	2.09	12.99	2.65	8.25	16	99	20	63	1111	153	7.30	60.33	12.85	40.18	11	92	26	61	20.1	XX sol.
		612					13	79	16	50	1112	95	7.65	62.65	6.77	48.23	7	60	6	47	15.5	XX sol.
	Total	....	....	....	....	....	149	1151	224	778	....	....	....	....	....	....	108	1,036	128	800	....	

Duplicate analyses of the above juice and sirup gave the following results:

Number of analysis.	Specific gravity.	Per cent. sucrose.	Per cent. glucose.	Per cent. solids.	Per cent. polarization.	Per cent. available sugar.
Juice, 182	1.057	8.48	1.48	3.41	8.54	3.59
Juice, 183	1.057	8.45	1.49	3.09	8.52	3.87
Sirup, 206	1.038	5.72	.67	2.92	....	2.13
Sirup, 207	1.038	5.93	.67	2.88	....	2.38

In the above, 40 grams of sirup was diluted with 300 c. c. of water for the purpose of analysis.

It will be seen that in the 57 pounds of juice used there was, in pounds—

Sucrose	4.82
Glucose	.84
Solids	1.85
Available sugar	2.13

And in the 9 pounds of sirup made—

Sucrose	4.46
Glucose	.51
Solids	2.22
Available sugar	1.73

Or there was recovered in the sirup of the amount present in the juice of—

	Per cent.
Sucrose	84.2
Glucose	60.8
Solids	119.8
Available sugar	81.3

There was nothing unusual in the character of this sirup. After a short time it crystallized to a semi-solid mass.

It would appear, therefore, that the sole difference between these Chinese sorghums and sorghums which have been examined by us heretofore is in known contents of sugar and juice which these contain, and that there is no reason to doubt but that the better varieties could be substituted for them, care being taken to select only such varieties as would mature in the northern part of China, where, as Minister Angell informs me, these sorghums are grown much as maize is in this country, and for the same purpose.

It is interesting to observe that in China, where for centuries the sorghums have been cultivated; in Turkistan, where, as Mr. Kuleshoff, of the Agricultural Academy of Moscow, informs me, sorghum is one of the leading crops; and in Africa and India, where it is the leading cereal, the chief value of this interesting plant has so long remained unknown. As a recent writer in the Natal News says:

It is strange that we should have learned from the Yankees of America the great value of a plant many varieties of which have been known to us and cultivated by us for centuries.

RESULTS OBTAINED ELSEWHERE WITH THE NEW VARIETIES FROM CHINA AND INDIA.

Small parcels of these new seeds, from China and India, were sent to different parts of the country for the purpose of securing a crop of the seed, in case these varieties should be found valuable, and in order to compare results obtained in different localities.

Portions of the six varieties of Chinese sorghums seeds were sent to forty-three individuals, and of the two Indian varieties, samples were sent to thirty-six individuals in different States. The amount of seed of the African varieties was so small that it hardly sufficed for the purpose of our own experiments.

The returns thus far received from those to whom these seeds were sent are almost unanimous, and accord with the results of our own experiments. The Chinese varieties are early; are productive in seed, one variety having a seed almost white; the panicles are spreading, thus enabling the seed to be easily dried without moulding; but the stalks contain but little juice comparatively, and that of an inferior quality, so far as the sugar contents, though a fair quantity of sugar was made from these canes, as seen in our experiments elsewhere detailed.

Besides, nearly every one of these Chinese varieties has the habit of putting out branches from each joint of the stalks early in the season, which is very objectionable. These six varieties are abundantly grown in Northern China for the seed, and the stalks and leaves are used as forage, and it is only for such use that they are to be commended to our farmers, while even for this purpose very many of our common varieties far surpass them.

In regard to the two Indian varieties the testimony is also equally unanimous and highly favorable.

In Colman's Rural World it says:

> The acre of sorgho planted by Mr. Hedges for the Saint Louis Fair Association on the 8th of June was one inch above the ground on the 13th, and the single row of seed from India was fully half an inch higher, &c.

Again, the well-known sorghum grower, Ephraim Link, of Greeneville Tenn., writes under date of November 6, 1882:

> I experimented this season with six varieties from China sent me from Washington. All proved worthless, little better, indeed, than broom-corn; also with two varieties from India. Both of these promise much, one especially was rich in juice to objectionable brittleness, and tested 11° by the saccharometer. I am very anxious to test them a better season and earlier planting. I planted June 3, from late receipt of seed and rain.

This seed was received from India almost too late for planting, but was sent out in hopes that it might be in season for some localities. This precaution was wise, since it has been found that the portion kept over was so infested with the larva of a specie of weavil that nearly every seed was destroyed by them and failed to germinate.

The results obtained at this Department with these two varieties may be seen by consulting analyses of Nos. 29 and 30.

ANALYSES OF SOILS.

The character and composition of the soils best adapted to the cultivation of sorghum for sugar production, as also the proper method of fertilization necessary for the best results, are obviously matters of fundamental importance.

At present our knowledge is very limited, and the number of carefully ascertained facts so small as hardly to warrant more than conjecture.

In many respects the habits of the sorghums and their demands upon climate and soil are almost identical with those of the several varieties of maize, and yet there appear to be in certain respects marked differences. It is known that when fairly established the sorghums as a class are capable of sustaining a period of drought which would prove fatal to maize, and not only this, but that such drought and the accompanying high temperature results in the development of an unusual amount of sugar in the plant.—(See Annual Report Department of Agriculture, 1881–'82, p. 456.)

It will be seen by consulting the results of our experiments as to the effects of fertilizers upon the sugar content and ash in the juices of the several sorghums (see Annual Report, 1880, pp. 118, 125) that, although a very large number of determinations were made, the average result of all was such as to leave the matter wholly unsettled.

To those who may desire to aid in these and similar investigations, a careful study of these results above referred to may be helpful as showing the extreme danger of hasty generalizations; for any half dozen of the analytical results, selected at random and considered alone, would, in most cases, warrant a conclusion, more or less decided, which the increase of testimony renders less and less probable.

The results of the past year at Rio Grande, N. J. (where they produced 320,000 pounds of sugar, and where, upon fields identical in character, there was great variation in the amount of crop produced), were such as to awaken great interest in these questions of soils and fertilization. Besides, the juices of the sorghums there grown proved to be remarkably pure, comparing well even with the best sugar-cane juice. Therefore, average specimens of the soils from the several fields were obtained, and a record of the yield of crop and the fertilizers applied to each was also secured from the president of the Sorghum Sugar Company, George C. Potts, Esq., of Philadelphia, Pa.

Rio Grande is a small hamlet some 6 miles north of Cape May, N. J., in latitude 39° north and longitude nearly 2° east from Washington. It is situated upon a sandy peninsula, about 5 miles in breadth, with the Atlantic upon the east and separated from the mainland by the Dela-

ware Bay, at this point about 20 miles wide. Average samples of soil from six fields were selected for analysis, viz:

A. *Harne farm.*—This field received an application of 300 pounds of Peruvian guano per acre. The average yield of stalks was 3½ tons per acre.

B. *Richwine farm.*—This farm also had 300 pounds Peruvian guano per acre. The average yield was 5½ tons of stalks per acre.

C. *Hand farm.*—This field received an application of 300 pounds of Peruvian guano and 30 bushels of lime per acre. The average yield was 7½ tons of stalks per acre.

D. *Neafie farm.*—This field received same amount of guano and lime as C. Average yield per acre, 8 tons stalks.

E. *Uriah Creese farm.*—Same amount of guano and lime as C and D. Average yield per acre, 15 tons stalks.

F. *Bennett farm.*—Same amount of guano and lime as C, D, and E. Average yield per acre, 17 tons stalks.

From the above results it will be seen that the application of the expensive fertilizer Peruvian guano was without any apparent benefit, while the application of lime seems to have been beneficial, although it is to be regretted that we have not the data for comparing the yield of these fields with and without the application of fertilizers.

With the exception only that the amount of pebbles of an appreciable size, one-twentieth to one-quarter inch in diameter, was more in some of the samples than in others, there was to the eye no noticeable difference in the character of the six.

The samples were passed through sieves of 20, 30, 40, 50, 60, 70, 80, 90 meshes to the inch, and the following results obtained: The column marked residue consisted of pebbles which would not pass through a sieve of twenty meshes to the inch, or rather of one-twentieth inch diameter. The column marked 20 was that portion which, passing meshes of one-twentieth inch, would not pass those of one-thirtieth, &c.

Besides these six samples of soil from Rio Grande, N. J., analyses have been made of several other soils upon which sorghum was grown the past year, as follows:

G. *Grounds of the Department of Agriculture.*—The recent treatment of this plot is given in the annual reports of the past three years. The sample for analysis was taken November, 1882.

H. *Soil No. 1—Great Bend, Kans.*—This soil has been cultivated for six years. The yield was 10½ tons stalks per acre. No fertilizer used.

I. *Soil No. 2—Great Bend, Kans.*—This soil was plowed for the first time. The yield per acre was 8 tons of stalks. No fertilizers were used.

J. *Soils from Rising City, Nebr.*, upon which 18 tons per acre of sugar-beets were grown, which gave, on analysis, an average of 12.27 per cent. of sugar in the juice.

K. *Soil from Hutchinson, Kans.*—Yield of sorghum, 6 tons stalks per acre.

L. *Soil from Sterling, Kans.*—Under cultivation for three years in cereal crops. A black, sandy loam. Average yield per acre, 7 tons stalks.

M. *Soil from Sterling, Kans.*—A black, sandy loam. Under cultivation for seven years with crops of cereals. Crop very promising, but destroyed by hail.

N. *Soil from Sterling, Kans.*—Black, sandy loam. Under cultivation for five years in cereal crops. Average yield per acre, 12 tons of stalks.

O. *Soil from Sterling, Kans.*—A strictly sandy soil; in cereals for five years. Average yield per acre, 10 tons of stalks.

Per cent. of soils passed through sieves.

	Residue.	20.	30.	40.	50.	60.	70.	80.	90.	Total.
A	27.8	4.2	5.9	3.6	2.5	3.0	4.3	3.9	44.8	100
B	22.7	5.1	8.9	7.8	5.0	6.0	11.2	6.4	26.9	100
C	3.0	6.7	17.6	16.5	8.8	8.8	11.4	10.6	16.6	100
D	5.7	7.2	16.7	13.6	9.6	8.2	9.8	12.0	17.2	100
E	8.2	6.2	12.2	8.7	7.5	6.9	9.8	8.3	32.2	100
F	5.5	6.9	18.6	12.5	8.7	9.4	9.7	8.0	20.7	100
G	5.5	1.6	6.6	7.2	3.9	3.6	5.1	7.9	58.6	100
H	2.2	1.1	2.9	3.3	3.7	2.6	7.3	6.8	70.1	100
I	.3	.3	.9	1.0	1.2	.7	2.2	4.5	88.9	100
J	.2	.5	.1	.1	.1	6	1.1	1.5	95.8	100
K	.7	.3	.8	1.0	.7	.9	2.1	2.0	91.6	100
L	1.8	3.0	7.4	5.6	5.1	3.1	4.6	4.6	64.8	100
M	4.9	1.4	3.3	3.2	2.1	2 7	4.2	3.3	74.9	100
N	1.0	.9	3.3	7.5	6.5	4.2	9.6	12.9	54.1	100
O	.9	1.6	9.2	8.6	11.3	9.3	14.6	14.7	29.8	100

The mechanical condition of a soil determines often its degree of fertility quite as much as chemical composition. This state of extreme comminution is said to account for the great fertility of the tchernozème or black soil of Southern Russia, which, upon chemical analysis, does not appear any better than ordinary soils, and yet its productiveness is such that, as has been said of it:

> The Russian proverb, "One cannot distinguish the generous from the rich," may be most appropriately applied to the tchernozème. It appears rich because it is generous.

It is commonly known that the mineral matter, which composes the larger part of every good soil, has been derived originally from rocks which during comparatively recent periods, geologically speaking, have been disintegrated by one agency or another, and that those supplies of mineral food necessary to the plant, in any soil, must have previously existed in the rocks from which this soil was produced.

But those agencies, as frost, water, attrition, the carbonic acid and oxygen of the air, which have in the past reduced these rock masses to every degree of fineness, from small pebbles to impalpable powder, are still operative; and gradually, year by year, day by day, new supplies of mineral food are being from these rock fragments and made available to the plant. Besides, it will be seen that as this pulverization goes on the surface exposed to the action of these agencies above mentioned

increases in geometric ratio, and so in consequence the disintegration becomes proportionately the more rapid.

To illustrate, suppose a block of granite 1 foot square to be broken into cubes of 6 inches square, there would be obviously eight cubes produced, and the surface exposed in the first case, being 6 square feet, would be doubled. Let this process be repeated, and the surface becomes 24 feet square. Continue this operation for only 25 times and our block of granite 1 foot square with 6 square feet of surface becomes resolved into minute fragments of quartz, feldspar, and mica, about one three-millionth of an inch in diameter, and presenting an aggregate surface of over 7 square miles; and yet there is no reason to suppose that the comminution ceases at such limits; indeed, there is every reason to believe that the plant is incapable of assimilating food which is not absolutely in the molecular condition.

The calculations of Sir William Thompson show the size of the molecule to be, at his largest estimate, only one hundredth the diameter, or one millionth the bulk, of the fragments to which we have reduced our block of granite in the above illustration.

The importance, then, of assisting these agencies by good tillage is obvious; indeed, an agriculturist of long experience and distinguished success has declared that he would prefer to have an ordinary field well plowed without manure than poorly plowed with it.

So far as the partial mechanical analysis goes it quite fails to throw any light upon the cause of the very wide difference in the crops grown upon the Rio Grande soils.

For example, the soils C, D, F are very much alike, and yet their respective yields per acre in tons of stalks were 7½, 8, and 17. It is obvious that much of this might have been due to difference in cultivation, but it does not appear that there was practically any difference in this respect.

CHEMICAL COMPOSITION OF THE SOILS.

The following table shows the results of the chemical analysis of the several soils. The absence of other than mere traces of chlorine in the Rio Grande soils is remarkable, in view of the fact that these fields were lying within a few hundred yards of the ocean. It is possible that the heavy fall rains had leached such compounds below the surface, from which alone the samples were taken for analysis. It is intended to make still further examination of the subsoils of these several fields, for it may be that sorghum, being, through its root system, a deep

feeder, will account for good crops of cane upon land which failed to grow good crops of other kinds:

	A.	B.	C.	D.	E.	F.	G.
Water	.830	.680	.190	.350	.430	.180	1.140
Organic	4.730	3.500	1.290	2.180	2.420	1.780	4.690
Insoluble	87.008	92.243	96.910	93.837	93.167	95.297	84.670
Fe_2O_3	2.555	1.775	.940	1.110	1.500	1.445	3.440
Al_2O_3	4.110	1.640	.550	1.765	1.805	1.060	4.360
CaO	.315	.305	.225	.375	.460	.505	.860
MgO	.390	.290	.147	.185	.180	.190	.367
K_2O	.238	.124	.061	.085	.122	.074	.394
Na_2O	Trace.	.023	Trace.	....	.012	Trace.	.023
P_2O_5	.088	.047	.024	.034	.043	.026	.265
SO_3	Trace.	Trace.	Trace.	Trace.	Trace.	Trace.	Trace.
Cl	.044	.009	.003	.004	.005	.003	.009
CO_2	....	....	....	.130	....	Trace.	Trace.
	100.308	100.636	100.340	100.055	100.144	100.560	100.228
Nitrogen	.128	.067	.045	.045	.078	.062	.146

	H.	I.	J.	K.	L.	M.	N.	O.
Water	1.000	.300	1.140	.330	.400	.470	.300	.360
Organic	4.320	5.820	7.320	4.830	4.310	5.150	2.520	1.330
Insoluble	85.250	84.625	78.162	86.282	87.792	81.832	91.544	94.231
Fe_2O_3	3.605	3.330	4.550	3.270	2.775	3.270	2.330	1.775
Al_2O_3	3.575	3.890	5.805	3.385	3.005	3.665	1.835	1.465
CaO	.710	.760	.715	.565	.660	2.685	.450	.505
MgO	.325	.450	.820	.595	.380	.690	.390	.230
K_2O	.524	.538	.686	.437	.482	.397	.301	.257
Na_2O	....	....	Trace.	.059	Trace.	.042	.050	Trace.
P_2O_5	.047	.046	.042	.026	.010	.017	.024	.017
SO_3	Trace.	.115	Trace.	.050	Trace.	.044	.036	.041
Cl	.004	.019	.017	.007	.027	.019	.019	.017
CO_2	....	....	....	....	....	1.695	....	....
	99.360	99.893	99.257	99.836	99.941	99.976	99.799	100.228
Nitrogen	.151	.190	.230	.162	.140	.146	.034	.050

For purpose of comparison, analyses are given of two sugar-cane soils from a pamphlet on the agricultural chemistry of the sugar cane by Dr. T. L. Phipson.

A is soil from Jamaica, under cane for the first time.

B is soil from Demerara which has been steadily under cane for 15 years.

	A.	B.
	Per cent.	*Per cent.*
Moisture	12.25	18.72
Organic matter and combined water	15.36	6.03
Silica and insoluble	48.45	68.89
Alumina	13.80	2.50
Oxide of iron	6.72	2.60
Lime	.99	.08
Magnesia	.29	.25
Potash	.11	.10
Soda	.70	.09
Phosphoric acid	.10	.03
Sulphuric acid	.30	.03
Chlorine	*.51	Trace.
Oxide manganese, carbonic acid, and loss in analysis	.42	.68
	100.00	100.00
Nitrogen in organic matter	.31	.05

*This quantity of chlorine is unusually high, and is accounted for by the proximity of a salt spring.

Dr. Phipson calls attention to the greater amount of organic matter, nitrogen, lime, and phosphoric acid in A, and to the important fact that the quantity of lime, .08, in B is far below that of the magnesia, .25. This he regards as a very bad sign in cane soil. He deduces from the results of a numerous series of analyses made by him that the degree of exhaustion which a cane soil has suffered may be determined by comparing the relative amounts of lime and magnesia present in them.

In support of this view, he gives analyses of four samples of cane soils from Guiana, A and B having been cultivated from ten to fifteen years and C and D having been cultivated over sixty years:

	A.	B.	C.	D.
Lime .... per cent..	.44	.64	.11	.40
Magnesia .... do....	.32	.50	.36	.51

In view of the above facts, it is not improbable that a similar explanation will suffice for the remarkable results obtained at Rio Grande, N. J.

In the following table the crop of stalks produced, with the per cents of lime and magnesia in the several soils, is given for purpose of comparison with ratio of lime to magnesia:

	Tons stalks.	Per cent. lime.	Per cent. magnesia.	Ratio lime to magnesia.	
A	3½	.315	.390	100	124
B	5½	.305	.290	100	95
C	7	.225	.147	100	65
D	8	.375	.185	100	49
E	15	.460	.180	100	39
F	17	.505	.190	100	38

It will be remembered that while each of the above soils had received an application of 300 pounds of Peruvian guano per acre, the soils C, D, E, and F had, in addition, received 30 bushels of lime per acre. It is also very interesting to observe that as the relative amount of magnesia compared with lime in the above soils fell off the crop of cane increased.

For purposes of comparison, the tons of stalks produced per acre, with the per cents of the lime and magnesia, and their ratio, is given for the other soils analyzed:

	Tons stalks.	Lime.	Magnesia.	Ratio lime to magnesia.	
G	15	.860	.367	100	43
H	10½	.710	.325	100	46
O	10	.505	.230	100	46
L	7	.660	.380	100	58
I	8	.760	.450	100	59
N	12	.450	.390	100	87
K	6	.565	.595	100	105

In the above list the order of arrangement is according to the ratio of lime to magnesia, and it will be seen that the crop from soil N is the only one which is fairly exceptional to the conclusions laid down by Dr. Phipson in his examinations of sugar-cane soils. The ratios of L and I are almost identical, and there is but a ton difference in the yield per acre; also the actual amount of lime present in I is greater than that in L.

The different modes of planting and of culture should, so soon as is possible, be subjected to careful experimental investigation. It is not improbable that by planting rows at wider intervals than has been customary will be found to add largely to the sugar content of the plant.

The results at Rio Grande, N. J., in the use of lime show the importance of determining the question as to what fertilizers are best suited for sorghum, not in increasing the crop, but in improving the quality of the juice as to content of sugar and coefficient of purity.

Especially are experiments desirable in the application of the various lime fertilizers, as superphosphates, sulphate of lime, quicklime, and powdered limestone.

The experiments in defecation should be repeated upon such quantities of juice as would determine the practical application of the methods.

The question of "available sugar," that is, the molasses forming effect of the solids other than sucrose in juices and sirups, should be determined by careful and repeated experiments.

Experiments looking to the utilization of the begasse, through drying it or preserving fresh in silos for food, in the recovery of the sugar it contains, and in the production of paper pulp from it, are very important and full of promise of economical results.

Thousands of acres of maize are grown for the purpose of canning, and it would be important to determine whether the stalks, after the removal of the immature ears, were not capable of being worked economically for sugar.

It is desirable to determine whether sirups can be made by the simple and inexpensive appliances in common use among the farmers, which, by subsequent treatment with the vacuum pan, centrifugal, and other improved and expensive apparatus of the refinery, could be readily converted into sugar, and thus show the farmer, on the one hand, that he could make a product valuable in the market as a source of sugar, and, on the other, convincing the refiner that he could afford to buy and work such sirups as he would the high-grade molasses from Cuba; thus introduce into centers of sorghum growing, refineries and a local market for these new farm products.

It appears also probable that by careful crossing of certain of our better varieties of sorghum new varieties might be obtained surpassing n desirable qualities any now known.

By reference to the Annual Report for 1880, p. 130, it will be seen that

the average results from the analyses of eleven varieties of sorghum were as follows:

Pounds stripped stalks per acre.	Per cent. juice expressed.	Pounds juice per acre.	Per cent. sucrose in juice.	Per cent. glucose in juice.	Per cent. solids in juice.	Days for working crop.	No. of analyses.
48,758	61.67	30,069	13.18	1.58	3.39	79	53
45,580	62.02	28,269	13.18	2.05	3.22	38	22
44,913	62.56	28,088	12.92	2.09	3.37	48	36
39,919	60.15	24,011	14.24	1.67	4.18	31	14
37,031	61.67	22,837	14.21	1.76	3.61	37	9
39,815	60.84	24,223	14.40	1.80	3.40	20	6
50,017	65.08	30,301	10.80	1.56	2.51	43	21
46,634	65.91	30,736	11.21	2.61	2.94	38	20
45,695	65.06	29,729	12.83	1.80	2.95	10	4
47,246	64.68	30,559	12.98	2.11	3.92	20	7
46,421	66.59	27,912	11.67	2.03	3.22	22	7
Av., 44,730	63.29	27,885	12.88	1.91	3.34	35	18

The general average of the eleven sorghums and the result of 199 analyses shows the presence of 7.63 per cent. of available sugar in these juices, or in the juice actually obtained an average of 2,118 pounds of sugar to the acre; while the average results from 53 analyses of the first variety given in list gives 3,087 pounds of sugar per acre.

Upon p. 464, Annual Report 1881–'82, the following results are given from analyses of eleven varieties of sorghum:

Pounds of stripped stalks per acre.	Per cent. juice expressed.	Pounds juice per acre.	Per cent. sucrose in juice.	Per cent. glucose in juice.	Per cent. solids in juice.
24,757	43.4	10,745	15.56	2.52	.99
34,667	46.3	16,051	16.52	2.07	1.69
26,426	48.6	12,843	14.62	1.62	4.45
29,512	50.7	14,963	13.60	1.67	4.55
33,333	50.9	16,967	13.96	1.35	2.91
33,041	49.8	16,554	16.29	.80	2.64
29,766	41.0	12,204	16.78	.66	3.02
32,103	48.8	15,666	16.78	.74	3.18
30,634	53.4	16,359	13.92	1.92	2.38
26,252	50.0	13,126	13.81	2.27	2.28
30,683	50.0	15,342	14.11	1.33	2.75
Av., 30,107	48.4	14,620	15.09	1.54	2.80

The general average of the eleven sorghums above given shows the presence of 10.75 per cent. of available sugar in these juices, or in the juice actually obtained an average of 1,572 pounds of sugar to the acre, while the average result from one of them gave 2,127 pounds of sugar to the acre.

It will be remembered that the season of 1881 was very unfavorable for the production of all crops in this vicinity, but I think it is far beyond even the hopes of most, as it certainly is beyond any results thus

far attained, to secure from an acre of ground over a ton of sugar from sorghum, and yet, as is shown in the above averages, such a result is not by any means unreasonable.

I think it would, then, be most desirable to attempt to secure such maximum result in sugar, in order to convince our farmers of the possibilities within their reach if only they conform in their practice to the principles laid down in this and previous reports.

Respectfully,

PETER COLLIER, *Chemist.*

Hon. GEO. B. LORING,
Commissioner.

INDEX.